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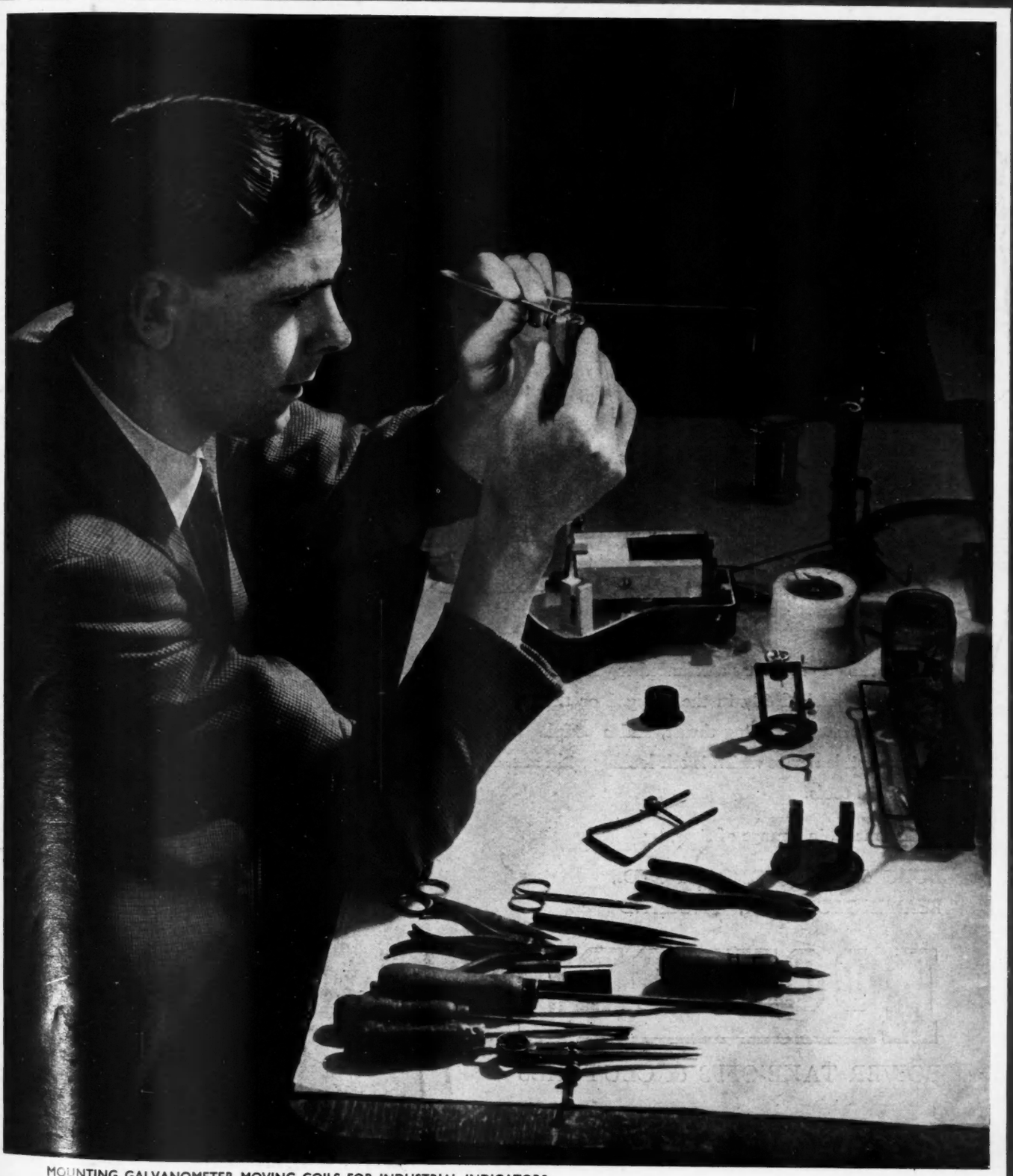

MOUNTING GALVANOMETER MOVING COILS FOR INDUSTRIAL INDICATORS.

ON A RUSTON "Y-E" DIESEL ENGINE

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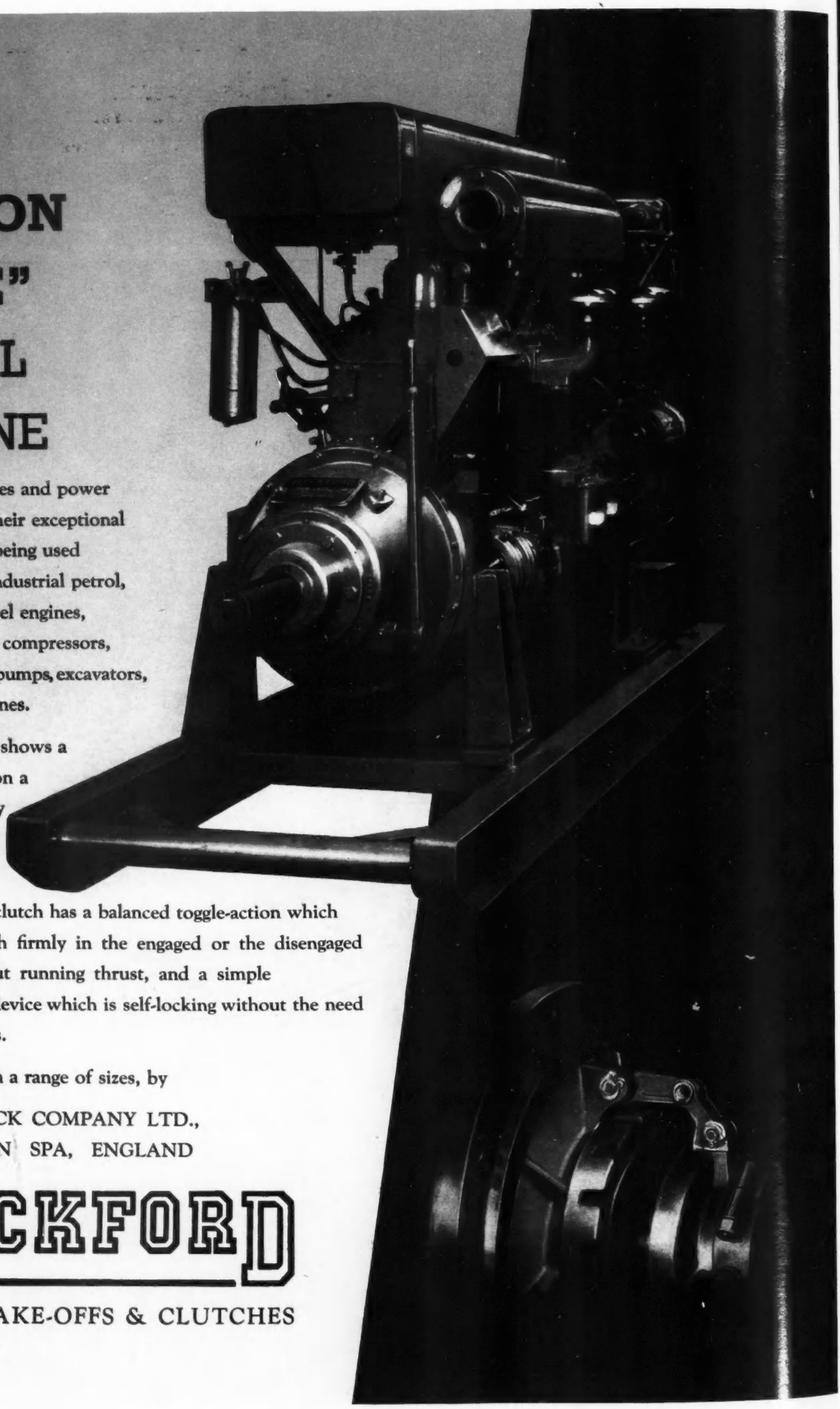

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POWER TAKE-OFFS & CLUTCHES

THE TUNGABHADRA IRRIGATION AND POWER SCHEME.

By R. DORAI RAJAN.

THE largest irrigation and power development scheme now being undertaken in Southern India is the River Tungabhadra project; it will benefit the famine-affected and industrially-backward Ceded Districts of the State of Madras, together with parts of the State of Hyderabad. The project, a joint undertaking of the two States, centres on the dam, shown in Fig. 1, which is being built across the Tungabhadra River, a tributary of the Kistna River, at Malapuram, about three miles from Hospet on the Hyderabad-Bellary border. The location of the dam with respect to Southern India was shown in the map which accompanied the article on the Lower Bhavani project in ENGINEERING of December 19, 1952 (vol. 174, page 777). An index map of the Tungabhadra project is given in Fig. 2, above. The catchment area of the river above the site of the dam is 10,800 square miles; the maximum annual yield, mainly contributed by the south-west monsoon, is estimated to be 604,700 million cub. ft. and the expected minimum yield, 296,000 million cub. ft.

The dam is 7,942 ft. long and has a maximum depth of 160 ft. over the deepest foundation. The principal section of the dam is a medium-sized gravity-type masonry structure, straight in plan, with a central spillway section 2,300 ft. long, flanked on either side by bulkhead sections having a combined length of 3,642 ft. Cross-sections of the spillway and bulkheads are given in Figs. 3 and 4, on page 162. A rolled earth-fill dam, 70 ft. high and 450 ft. long, has been built on the extreme left flank to close a low-lying saddle. A second gap, 1,550 ft. long, on the same flank, has been filled by a composite dam comprising a masonry wall backed by earth; a section of this composite dam is given in Fig. 5, on page 162. The construction of its wall was similar to that employed for the main section of the gravity dam, which is described below; behind the wall, a semi-impervious material has been used for the earth-fill, which has been laid with a back slope of 2 to 1, broken by horizontal berms at suitable intervals. Protection of the filling has been obtained by turfing the slopes. A horizontal graded filter at the base, together with a loose rock-fill toe, has been provided to drain the earth-fill. The cubic content of the masonry dam is 32 million cub. ft. and that of the earth-fill dam and the composite dams is 10 million cub. ft.

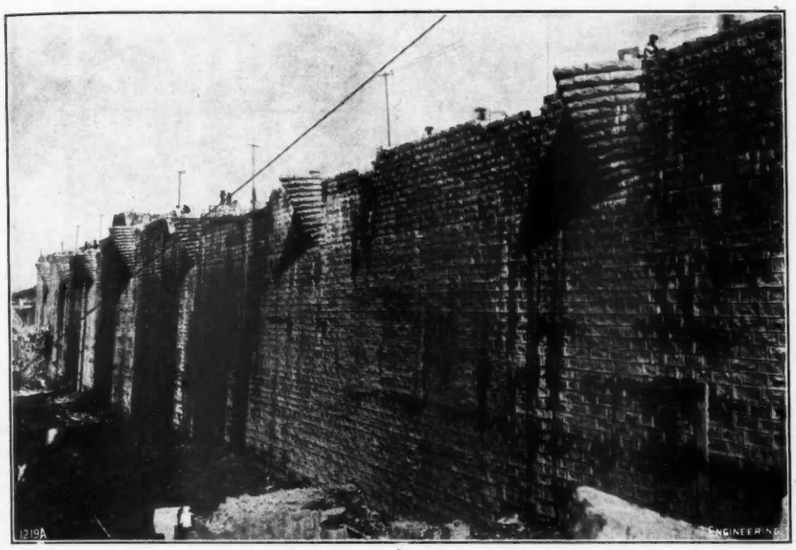
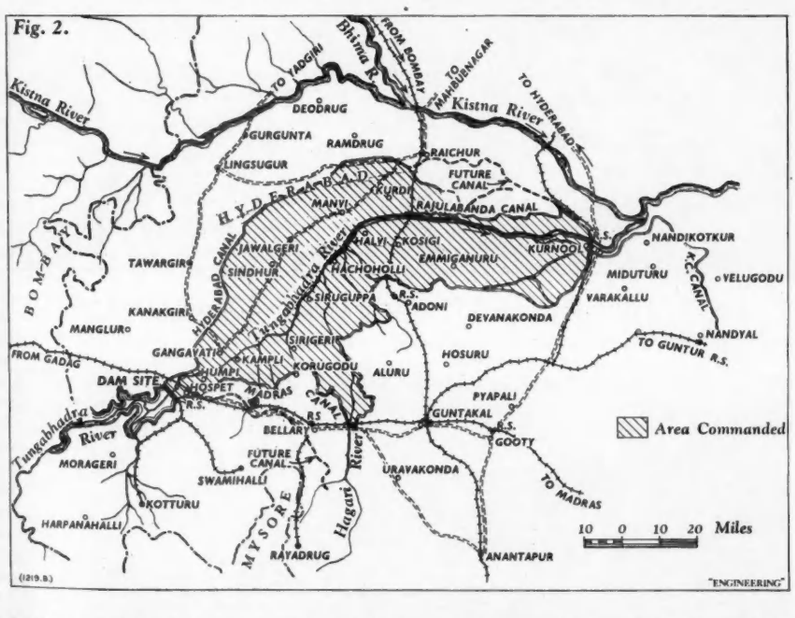


FIG. 1. WATER FACE OF DAM, WITH CORBELLED BRIDGE PIERS.



The spillway is of the "ogee" type, having a curved bucket and a depressed floor at the rear, and with a masonry apron extending 100 ft. downstream, as far as the baffle wall, as shown in Fig. 6, on page 162. The apron has been dispensed with at those points where sound rock comes to the surface. Piers above the spillway support reinforced-concrete bridges carrying the roadway, 22 ft. wide, which crosses the dam. The spillway has been built with granite stones set in a 1 : 4 cement mortar, 20 per cent. of the cement being replaced by *surki*, a pozzolanic material consisting of a finely-ground brick powder. The mixture, besides improving the workability, reduced the heat of hydration and, by its cheapness, kept down the cost of construction. The bulkhead sections on either flank of the spillway were similarly constructed with granite stones, but these were set in a lime *surki*, the proportions of lime, *surki* and sand generally being 1 : 1 : 1. Where the blocks have been built round sluices or penstocks, a 1 : 4 red-cement mortar has been used up to a level of 48 ft. above the river bed; above that level, a 1 : 5 mortar has been used. For the impervious face of the dam, which is 9 ft. thick, the stones have been set in a richer red-cement mortar with proportions of 1 : 2¾. The profile of the bulkhead sections of the dam can be seen in Fig. 8, on page 163.

The maximum observed flow in the river is 330,000 cusecs; in order, however, to minimise the risk of flooding, the spillway has been designed to take a maximum flood discharge of 660,000 cusecs. Thirty-three lift gates, each 60 ft. long by 15 ft. high, have been built above the crest of the spillway to control the river flow, and arrangements have been made so that, at some time in the future, the height of the gates may be raised by 20 ft. The reservoir impounded by the dam has a gross capacity of 118,126 million cub. ft. at the top level, 118 ft. above the river bed, but the dam has been so designed that the water level may be raised by 5 ft. to increase the quantity impounded to 138,659 million cub. ft. The water area of the reservoir, when full, will be 133 square miles, extending 100 miles upstream and submerging 65 villages in the States of Bombay, Hyderabad and Madras.

The bed rock below the foundations has been sealed by both "blanket" and "curtain" grouting. To make the shallow "blanket," holes were driven in three rows, with a maximum spacing of 40 ft. in any direction, to a depth of 20 ft. The grout, which had a water-cement ratio of between 10 : 1 and 2 : 1, was forced into the holes under a pressure varying between 70 lb. and 100 lb. per square inch. Drilling and grouting for the curtain was deferred until the masonry of the dam had been built up to the level of the floor of the drainage gallery, so that the additional depth of the drilled holes was available for developing the necessary head for high-pressure grouting. About 125,000 linear ft. of low-pressure grouting holes and 6,500 linear ft. of high-pressure grouting holes were drilled and grouted.

A drainage gallery, 5 ft. wide by 7 ft. 6 in. high, extends throughout the length of the masonry dam, about 10 ft. above the foundation rock and along a centre line 17 ft. 6 in. behind the axis. It is approached by transverse passages at each end of the spillway section of the dam. The roof of the gallery can be seen in Fig. 6, herewith. A drain, 1 ft. square in section, has been provided along the gallery to take the seepage to suitably located pumps. Contraction joints are provided in the spillway section at intervals of 93 ft. 4 in., strips of copper being used to make the seals near the upstream face and the sloping rear face of the

TUNGABHADRA IRRIGATION AND POWER SCHEME, MADRAS.

Fig. 3. LARGEST SPILLWAY SECTION.

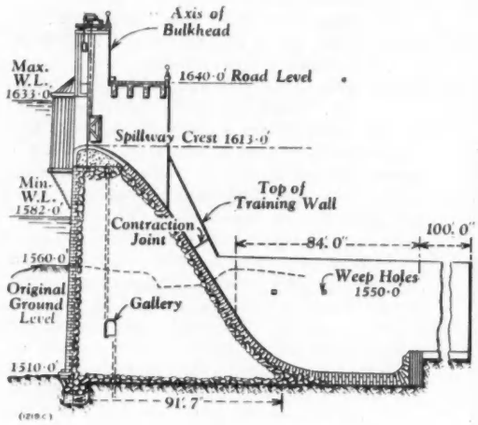


Fig. 4. LARGEST BULKHEAD SECTION.

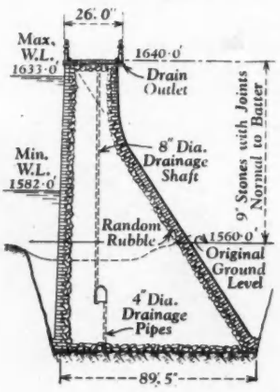
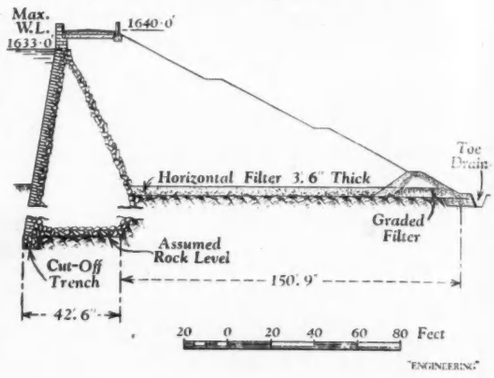


Fig. 5. CROSS-SECTION OF COMPOSITE DAM.



dam. There are no contraction joints in the bulkhead sections, except in the vicinity of the sluices, where the stones have been set in the red-cement mortar.

Cofferdams, provided with openings and built in masonry, were used to divide the river bed into three sections, so that when the river was low it could be diverted through any one of the sections while the building of the dam proceeded in the other two. Fig. 7 shows the construction in progress in the central section of the cofferdam while the diverted river flows through the section beyond. Four temporary sluices were built into each bulkhead section, sufficient to enable the diverted river to be passed until the permanent outlets were capable of taking the flow. The construction sluices were then plugged.

On the right flank, the Madras irrigation canal is fed by ten high-level sluices, each 6 ft. wide by 12 ft. high, built with their sills 75 ft. above the river bed. The speed of the water along the canal is expected to reach 4½ ft. per second. Another sluice of the same size, 45 ft. above the river bed, will be used to control the compensation water for the established irrigation along the river course. Four penstock pipes, 11 ft. in diameter and also 45 ft. above the river bed, will be used to feed turbo-generator sets, the tail water passing to irrigation. Two additional river sluices have been provided for use in an emergency. On the left flank, the Hyderabad irrigation canal will be served by two high-level sluices, each 4 ft. wide by 5 ft. high, and ten additional sluices, each 8 ft. 9 in. wide by 11 ft. 6 in. high, will be available for the purpose of irrigation and power generation. The speed of the water along the Hyderabad canal will be 3 ft. per second. When completed, the Madras canal will be 225 miles long, with a bed width of 72 ft. and a depth of 10½ ft. The Hyderabad canal will be 127 miles long, 84 ft. wide at the bottom, and 14 ft. deep. Both canals, carrying 2,500 and 7,000 cusecs, respectively, pass through rough country for the first 20 miles and the fall on both is to be used for the generation of power.

The most important engineering work on the canal systems was the construction of the aqueduct over the Hagari River, on the Madras side of the project. This aqueduct, 2,287 ft. long between abutments, is the longest in Southern India and consists of a reinforced-concrete trough divided into two channels, each 12 ft. wide by 9 ft. 2 in. deep. It is carried on masonry piers, at 35-ft. centres, founded on hexagonal caissons sunk 25 ft. into the sandy bed of the river. Each of the 58 river channels below the aqueduct is capable of

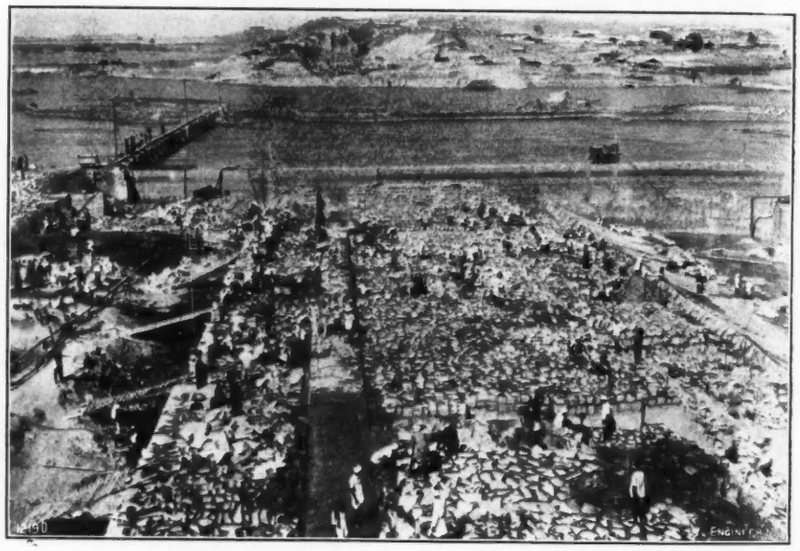


FIG. 6. EARLY CONSTRUCTION WORK ON THE SPILLWAY SECTION OF THE DAM.

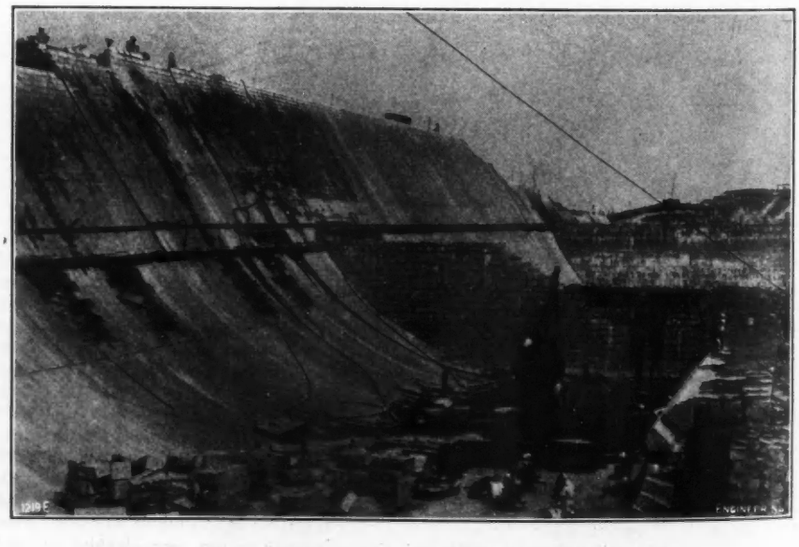


FIG. 7. "OGEE" SPILLWAY, TRAINING WALL AND BAFFLE WALL.

TUNGABHADRA IRRIGATION SCHEME.

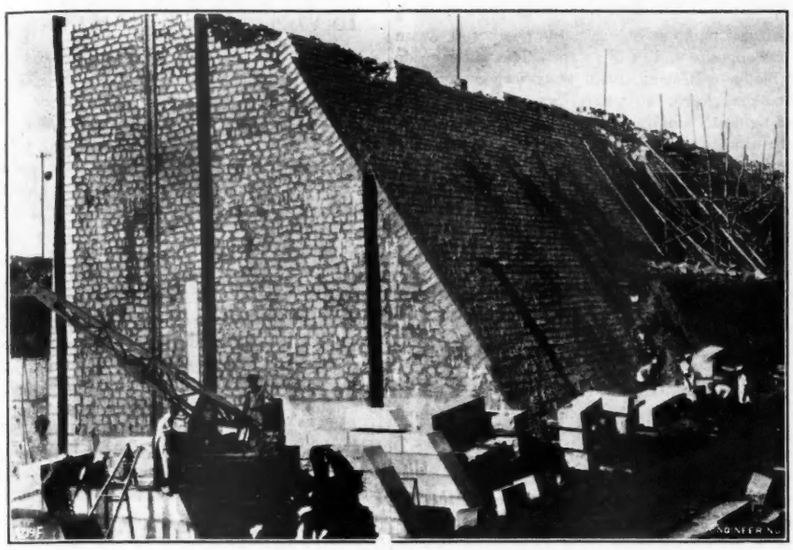


FIG. 8. BULKHEAD SECTION OF THE DAM.

passing a flow of 185,000 cusecs. The irrigation scheme will serve a total area of nearly two million acres. The Madras canal will irrigate 860,000 acres for raising 60,000 tons of grain and 40,000 tons of commercial crops. Water from the Hyderabad canal will irrigate 1,080,000 acres for raising 80,000 tons of grain and another 40,000 tons of commercial crops.

The Tungabhadra hydro-electric development is one of five such schemes included in the second five-year plan for the State of Madras, though it had been sanctioned, as a subsidiary to the main irrigation scheme, before the plan was published. Power will be generated at the site of Tangabhadra Dam, from the head available in the reservoir, as well as at a point 15 miles down the Madras canal, utilising the fall in water-level of 110 ft. The scheme will be developed in four stages as the demand for power in the area increases.

At the dam, the water for power generation for Madras will be drawn through four steel pipes, each 11 ft. in diameter by 110 ft. long, at intervals of 50 ft. apart and 40 ft. above the river bed. Each pipe will discharge 1,550 cusecs to feed Kaplan turbines of 12,000 h.p., coupled to generators each having a capacity of 7,500 kW. The maximum head above the turbines will be 85 ft. at full reservoir, falling to 45 ft. at low water. The first stage of the project, now completed, comprises two such units at the dam. The power house has a length of 203 ft. and a width of 65 ft. 9 in. The water discharged from the turbines is taken along a power canal to a point 15 miles away, near the famous Hampi ruins, where, as stated, there will be a head of 110 ft. to generate power at the canal power house. At the 14th mile of the power canal, a forebay has been constructed to provide a storage of 26·25 million cub. ft., which will be used to meet the variations in the load demand. From the forebay the water is taken through two low-pressure pipes, each with a diameter of 18 ft. and 2,640 ft. long, and having a capacity of 2,040 cusecs, and is discharged into two surge tanks, one designed to meet present requirements and the other to provide for future developments. Each tank has a diameter of 60 ft. and is 45 ft. deep. Four penstocks, 12 ft. in diameter by 500 ft. long, and each having a maximum discharge of 1,050 cusecs, will supply four Francis turbines of 12,000 h.p., coupled to 7,500-kW generators. Only two of these units are required for immediate use. The water will then be taken through a tail-race channel to join a natural stream, the Guntalakeru Vanku, where a suitable regulator and head-sluices are to be constructed to control the water for irrigation. The canal power-house will have a length of 155 ft. and a width of 60 ft.

With the completion of the first stage of the scheme an effective power capacity of 22,500 kW is available, with transmission mains to Bellary, Kurnool, Kodur and other places. The second stage, to be undertaken at about the sixth year of operation of the scheme, will involve adding a third unit at the canal power-house. In the third stage, after ten years, a fourth unit will be installed at the canal power-house and a third in the power-house at the dam, to meet the expected increase in demand. In the fourth and final stage, a fourth power unit will be added at the dam. When the scheme is finally completed, power will be available for the districts of Bellary, Anamtapur, Kurnool and Cuddapah, and it will no longer be necessary to import current from the neighbouring State of Mysore.

Hydro-electric power for the State of Hyderabad will be generated both at the dam and at four falls along the Hyderabad canal. It is intended that the total output shall be 110,000 kW, which will be used by the existing cottage industries and by the other medium-sized industries that are to be developed in the locality. The whole of the Tungabhadra hydro-electric development scheme will be connected to the thermal stations at Anamtapur, Kurnool, Nadyal, Prodattur, Tadpatri and Cuddapah, to form a power grid for the district.

The initial cost of the Tungabhadra irrigation and power development scheme as been assessed at Rs. 73 million and this figure is expected to increase to Rs. 79½ million by the end of the tenth year of operation. The construction of the dam and the irrigation canals has been under the direction of Mr. M. S. Thirumale Iyengar, for Madras, and Mr. P. Papiah for Hyderabad. Mr. S. R. Krishnamurthi, chief construction engineer, and Mr. G. Sundaram, chief electrical engineer, Madras, have been responsible jointly for the development of the hydro-electric power schemes.

ATMOSPHERIC POLLUTION.—In reply to a recent Parliamentary question, Mr. Ernest Marples, Parliamentary Secretary to the Ministry of Housing and Local Government, said that 186 local authorities in England and Wales maintained stations for the assessment of atmospheric pollution, and that no fewer than 32 of these authorities were in Lancashire.

LITERATURE.

The Farmer's Tools, 1500-1900.

By G. E. FUSSELL, F.R.Hist.S. Andrew Melrose, Limited, 11, Stratford-place, London, W.1. [Price 42*s.*]

THE author of this excellent book is not altogether unknown to readers of ENGINEERING, for he contributed to our 156th volume a study of "Steam Cultivation" which attracted considerable attention at the time and still brings occasional inquiries for copies of the issues (those of July 30 and August 13, 1943). It will save possible future inquirers some expenditure of time and postage stamps, perhaps, if we mention that the issues are now out of print. That article was not, by any means, Mr. Fussell's first venture into authorship; that appears to have been the *Chronological List of the Early Agricultural Books in the Ministry of Agriculture Library*, published by H.M. Stationery Office in 1930, the compilation of which must have provided an admirable foundation for the historical researches which have occupied so much of his attention since then. The award of a Leverhulme Research Fellowship assisted him to round off the labours of many years of careful accumulation of material, and, as a result, the literature of agricultural implements and machinery has been enriched by the addition of a work that is assured of appreciative readers for many years to come.

The broad scheme of the book is that followed by the poet James Thomson, more than two centuries ago—to follow the seasons round the year; in this case, by describing the appliances used and tracing their history and development—with the addition, however, of chapters dealing with more general matters which are not applicable to one season only. The study opens with a chapter on field drainage, passing thence to the processes of preparing the seed bed, sowing the seed, harvesting the crops, and threshing the grain. Chapter VI deals with "Barn and Miscellaneous Machinery," including milking machines; and the concluding chapter, "Brief Retrospect"—but so brief as hardly to qualify as a chapter by comparison with the others—is followed by a section of "Notes" which testify to the extent of the author's reading, a good chronological list of tools, a useful glossary of farming terms, and a bibliography which, in effect, is a continuation of the "Notes." A separate list is given of Mr. Fussell's own writings, and there is a serviceable index. The illustrations are a worthy accompaniment to the text. The book is pleasant to read, and should encourage the thoughtful reader to follow up many of the references given.

General Discussion on Heat Transfer, 1951.

The Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1. [Price 45*s.* net]; and The American Society of Mechanical Engineers, 29, West 39th-street, New York.

ENGINEERS interested in heat transfer will remember that, in 1951, a general discussion of the whole subject was organised jointly by the Institution of Mechanical Engineers and the American Society of Mechanical Engineers, with the support of 51 other technical bodies on both sides of the Atlantic. The sessions opened in London in September and a continuation was arranged to take place at Atlantic City, New Jersey, to coincide with the annual meeting of the A.S.M.E. in November. The proceedings of both meetings, together with the written contributions, are now made available in the present well-bound volume, which also includes the James Clayton Lecture on the "Condensation of Vapours," delivered during the London meeting by Professor Allan P. Colburn, Provost of the University of Delaware. Altogether, 93 papers were submitted and 229 members took part in the discussions, either orally or by writing. To make it

possible to deal with so many papers in a reasonable time, they were classified into five groups, and each group was presented in a summarised form for the purpose of discussion. Sixteen papers on heat transfer during change of state, i.e., under evaporating or condensing conditions, constituted the first group; the second consisted of 23 papers on heat transfer between fluids and surfaces; the third, containing 16 papers, dealt with the conduction of heat by fluids and solids; the fourth contained 18 papers, concerned mostly with radiation, instruments, and measuring techniques; and the fifth and last group comprised 20 papers coming under the heading of "Special Problems."

It would obviously be impossible to give anything like a full account of such a mass of information within the limits of a review, but it must be said that the great majority of the papers were of a kind likely to be of much more interest to theoretical physicists than to engineers. In the discussion of the first group, one speaker expressed wonder why the authors of three papers on the condensation of steam took so much trouble to base their investigations on laboratory conditions, which bore no sort of resemblance to those obtainable in practice, and another speaker had the temerity to describe the work as merely "research for the sake of research." Although nobody was so outspoken at other meetings, the comments mentioned might not be thought out of place with regard to many other papers, even by those who fully realise that some of the "raw science" of to-day may possibly be found useful in future. An engineering outlook was evident, however, in some of the papers, notably one by Mr. R. H. Smith dealing with the effect of the "dirt factor" on the performance of heat exchangers, written in the light of practical tests carried out over a long period on a very wide range of plant in the Billingham Works of Imperial Chemical Industries, Limited. Another paper of engineering interest, describing the Heenan and Froude mechanical water-cooler, drew from Professor A. P. Colburn the opinion that the difficulty of designing cooling towers was a "myth," fostered by the constructors of such plant; in support of this contention he indicated a practical basis of design sponsored by the American Society of Heating and Ventilating Engineers.

Among the practical papers must also be included one on "The Possibilities of the Heat Pump in Canada," by Professor E. A. Allcut and Mr. F. C. Hooper, both of Toronto University. Its most interesting feature relate to the design of a heat pump to serve isolated settlements in the Arctic regions, where air temperatures may reach 50 deg. F. below zero and the ground is permanently frozen. The heat had therefore to be obtained by the freezing of water, pumped at 32 deg. F. from beneath about 8 ft. thickness of ice on the lakes. When tested on site, the heat pump delivered about 170 per cent. of the higher calorific value of the fuel used in the 15-h.p. Diesel engine driving the plant, or about 2½ times as much as would be obtained from the same fuel by direct burning. The cooling of gas-turbine blades was dealt with particularly in three papers, of which perhaps the most important was a general survey, by Mr. Herman Ellerbrock, of the theory of different methods of cooling, including the use of porous blades, the paper being based on work carried out for the American National Committee for Aeronautics.

There was also a mathematical disquisition by another author on the "Theory of Effusion Cooling," which might have been more helpful if the reader had been given the least notion of the process supposed to be under discussion. No such criticism can be directed at a paper by Professor Ernst H. W. Schmidt, on the internal water-cooling of blades, which is admirable in its clarity. In his method, the blades are drilled through lengthwise, the outer ends of the holes being stopped by welding, and the inner ends left open to communicate with circumferential grooves inside the rotor. Water is supplied to these grooves by a centrifugal pump at one end, and escapes as steam at the opposite end of the rotor. The water inside the blades is held at about its critical pressure by centrifugal force, at which pressure its specific heat tends to uniformity and its viscosity to zero, both conditions being practically ideal for the absorption of heat. A four-stage gas turbine of 2,000 h.p. at 20,000 r.p.m. was stated to have been constructed on this principle.

Prestressed Concrete Structures.

By DR. AUGUST E. KOMENDANT. McGraw-Hill Book Company, Incorporated, 330, West 42nd-street, New York 36, U.S.A. [Price 10 *dols.*]; and McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4. [Price 42*s.* 6*d.*]

AT a recent meeting held at the Institution of Structural Engineers in London, Professor G. Magnel addressed a forceful demand to all engineers concerned with prestressed-concrete structures that they should take every care against making a mistake; because, if a single prestressed-concrete structure were to fail, the whole practice of prestressing concrete would be condemned and no public authority would dare to sanction the erection of future structures using such a method. In order that such an occurrence shall not befall, it is of paramount importance that all concerned with either the design or the practice of prestressing concrete should be fully aware of the properties and limitations of their materials and of the implication of the design methods that they use. It may be argued that, during the post-war years, during which time prestressing has developed from a novelty employed by a few pioneers to an accepted practice adopted by many designers, there has been no dearth of papers on the subject to the learned societies or of articles in the technical Press, so that those who are interested probably have available to them more printed matter than they are able to cope with. The nearer this is to the truth, the greater is the need for a single comprehensive book that will cover the entire subject within manageable limits. This has been attempted within the 260 well-illustrated pages of Dr. Komendant's book.

The requirements of a general survey of the subject are fourfold: a statement of the properties of the two principal materials, a discussion of design procedure, a description of the constructional methods available and, perhaps most important of all, a critical review of a selection of prestressed-concrete structures already built. These requirements are met in this book. The value of the fourth item is great, for it enables the engineer to approach a new project with the advantage of example before him. The design methods for prestressed concrete developed in published papers have never been straightforward in appearance and, in this respect, the present book differs in no way from its predecessors. Within the limits required for rational engineering design, the various factors involved are probably now known with sufficient accuracy: but the publication of lengthy formulae continues, each containing many different symbols and attempting to give a single all-embracing equation in which it will be only necessary to substitute a set of known, or assumed values to be able to deduce the final design dimensions. This is neither practicable nor desirable, and it is not good engineering. If good designs are to be executed, engineers must be able to recognise clearly each step in their design and, to this end, multiple formulae are of no value. Indeed, they are likely to lead to poor designs, for some designers may be temped to use them without making an effort to learn and to appreciate the origin and development of the tools they use.

MECHANICAL PROPERTIES OF ALLOY STEELS IN INVESTMENT CASTINGS.

By S. C. CHURCHILL.

IN the investment casting process, the refractory moulds are formed round patterns or groups of patterns, previously cast in wax or in fusible alloys of low melting point. After a preliminary drying treatment of the mould, the expendable patterns are melted out and the mould is baked and fired. The firing or vitrifying temperature is usually in the range 850 deg. to 1,000 deg. C. The moulds are maintained at high temperature until the casting metal is poured in from the carbon-arc or high-frequency melting furnace. The precise pouring temperature is determined by the complexity of the casting shape and the degree of fluidity required in the metal, and varies with the alloy composition.

Raw material fed into the furnaces consists either of machine cuttings or rolled bar, complying with the specification required in the castings. It is claimed for both types of remelting furnaces that no appreciable losses occur from oxidation. It is possible to obtain alloy steels with analyses showing high percentage values for the more oxidisable elements and this may be regarded as a reasonable safeguard against serious changes in composition. For detail parts, subject only to nominal stresses, the composition is not of primary importance, but where structural parts bear definite loads the composition and the mechanical properties must be proved by analysis and test. It has been the writer's experience that no assumptions with regard to tensile properties are valid if based entirely on the values stipulated in the original specification. This statement applies to castings accepted as radiographically sound.

Analysis of castings does not present difficulty to well-equipped investment foundries, but few possess the resources for carrying out full-scale heat treatment and testing on a production basis. In the absence of this procedure, it is not permissible to release the castings to the user as complying with the terms of the specification. The difficulty has been overcome in some cases by certifying on the release document that the castings are to the relevant specification and that the material is in the annealed condition. From this it would appear that the user needs only to complete his machining schedule, heat-treat to the requirements of the specification, and assemble the parts in the unit.

The belief that the castings are annealed is presumably based on the fact that they cool in and with the moulding flask to room temperature. The cooling rate may be comparable with that of an annealing furnace, but the prior condition of the castings is not comparable with steel which has been taken up to and cooled from the annealing temperature. Steels which are forged at high temperatures are being continuously recrystallised as they cool down to the lower critical temperature where forging ceases. Hot working of the metal eliminates the cast structure of the ingot, refines the grain structure and facilitates diffusion of the alloying elements. Maximum mechanical strength is developed in the direction of working. It is usual to normalise forgings before release to the user.

Investment-cast steels retain all the undesirable properties which hot working eliminates. In the change from the liquid to the solid state, large austenite grains are formed and the structure is strongly dendritic. In Figs. 1 and 2, opposite, the structure of a chrome-molybdenum steel is shown at low magnification; the condition is "as cast" and cooled in the mould. Fig. 1 is a study of the microstructure near the centre of the specimen, and Fig. 2 is at the extreme edge. The first illustrates the grain size and shows some evidence of the dendrites reaching in from the earlier cooled sur-

ALLOY-STEEL INVESTMENT CASTINGS.

FIG. 1. CHROME-MOLYBDENUM STEEL; AS CAST AND COOLED IN THE MOULD. × 20.

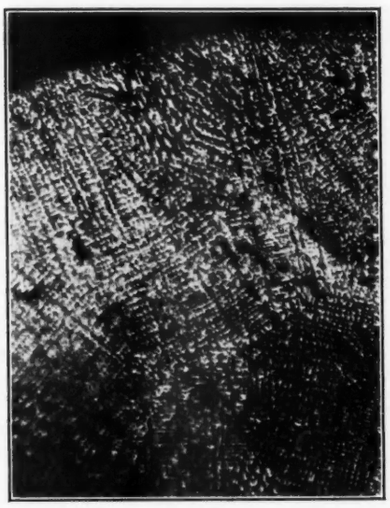


FIG. 2. AS FIG. 1, AT EXTREME EDGE. × 20.

FIG. 3. CRACKS IN HARDENED AND TEMPERED CHROME-MOLYBDENUM STEEL. × 80.

faces. The strongly dendritic character of the metal is evident from the second illustration. Tensile tests were made on nine specimens of this steel in the "as cast" condition. Before remelting, the material complied with the requirements of D.T.D. 306 in respect of composition and mechanical properties in the bar form, as shown in Table I.

TABLE I.—*Composition and Properties of Low-Alloy Steel, D.T.D.* 306

Element.	Per Cent. Min.	Per Cent. Max.
Carbon	0·15	0·35
Silicon	—	0·35
Manganese	—	0·65
Sulphur	—	0·05
Phosphorus	—	0·05
Nickel	—	0·30
Chromium	2·5	3·50
Molybdenum	0·3	0·70

Mechanical Property.	Requirement.
Proof stress 0·1 per cent.	45 tons per square inch.
Maximum stress	60-70 tons per square inch.
Elongation	17 per cent. minimum.
Izod	35 ft.-lb. minimum.
Brinell number	269 to 321.

The only results obtained from the tests related to the ultimate tensile strength, the absence of any measurable ductility precluding other tensile values from being calculated or observed. A single specimen of this group was normalised at 900 deg. C. (30 minutes soak) and examined at 25 and 100 magnifications. It did not differ materially from specimens in the cast state and, since the hardness values were in the same range, it was concluded that the desired improvement in ductility would not be achieved by normalising treatment.

Six further specimens from the same cast were annealed at 900 deg. C. Unfortunately, the treatment was not under laboratory control and no time records were obtainable. These specimens were tensile-tested and the results are given in Table II, herewith, together with the tensile strength and hardness values of the "as cast" specimens. The average ultimate tensile strength of the seven specimens, as cast, is 52·95 tons per square inch, with no measurable ductility. For the annealed specimens, the average of six is 31·1 tons per square inch, with an average elongation of 21·7 per cent. on a 1-in. gauge length. Whatever may be the explanation of the high hardness values and the high strength of the specimens in the cast condition, it is evident that they do not approximate in mechanical properties or microstructure to the annealed steel.

To complete the investigation, six specimens of the same steel from the same cast were hardened and tempered. Again, only ultimate-strength values were obtained and these are given in Table II. The average value of 50·75 tons per square inch is some 2 tons less than the corresponding value for the cast specimens. The explanation for this may lie in the condition of the steel structure, which is shown at 80 magnifications in Fig. 3, herewith. The cracks which show in this illustration were numerous and widespread over the whole area of the prepared specimen, which was one not subjected to strain other than that occasioned by the oil quench from the hardening temperature.

The cracks, in the general case, appear to follow a ferritic boundary line, which suggests that this may be the outline of the original austenite grains as depicted by the ferrite deposition along austenite boundaries shown in Fig. 1. Apart from this, there was some slight appearance of dendrite persistence in parts of the structure, which, coupled with the lack of precise information about the annealing treatment, indicated the need to examine the annealed specimens microscopically. One specimen of the six referred to in Table I was polished and etched over an area remote from the fracture. The annealed structure is shown in Fig. 4, on page 166, and the manner in which the ferrite masses outline the original cast structure is evidence that complete annealing had not been effected. While this does not invalidate the conclusion that the cast metal is far from being in the annealed state, it does render valueless any results obtained from the hardening and tempering treatment. It was decided, therefore, to make a full investigation of the treatment necessary to obtain satisfactory annealing, and then to make tensile tests on a number of annealed specimens, heat-treated according to the recommendations of Specification D.T.D. 306.

An annealing temperature of 950 deg. C. and a soaking time of 2 hours was found to give the most satisfactory microstructure after some experimental trials above and below this temperature, but with the same time factor. The structure is illustrated at 80 magnifications in Fig. 5, on page 166; it will be seen that there is no evidence of the cast structure, but the grain size is still too large. The grain size and distribution were the best obtained with freedom from dendritic influence. It was decided to normalise this structure to refine the grain size, and the effect is seen in Fig. 6, on page 166; it may be considered reasonable as a preparatory condition for hardening. The microstructure obtained by heating to 900 deg. C. in a neutral salt bath and quenching in oil is shown in Figs. 7 and 8, on page 167. This, and the microstructure obtained by tempering for one hour at 600 deg C. in a muffle, are quite typical of the structure

TABLE II.—CHROME-MOLYBDENUM STEEL SPECIMENS, TESTED AT DIFFERENT STAGES OF HEAT TREATMENT, COMPARED WITH CAST SPECIMENS FROM SAME MELT.

Specimen Ref. No.	Condition of Specimen.	Maximum Stress, Tons Per Sq. In.	Vickers Hardness and Corresponding Tensile Strength. V.P.No.	Tons Per Sq. In.	Remarks.
1	As cast	—	—	—	Porous fracture.
2		54·5	—	—	
3		54·8			
4		54·0	312	69	Dull smooth polyhedral facets.
5		50·5	to	to	
6		55·5	395	87	
7		49·2			
8	Annealed	—	—	—	Porous fracture.
9		52·2	—	—	
10		31·9	—	—	All fractures exhibit ductility.
11		29·6			
12		35·5	153	33·5	
13		30·4	to	to	Microstructure indicates.
14		29·3	168	37	
15		29·8	—	—	Strongly dendritic character.
16		49·3	—	—	
17	Hardened and Tempered	56·9			
18		48·5	280	61·5	
19		47·7	to	to	Intergranular cracks in microstructure of all specimens.
20		53·6	395	87·0	
21		48·5	—	—	

ALLOY-STEEL INVESTMENT CASTINGS.

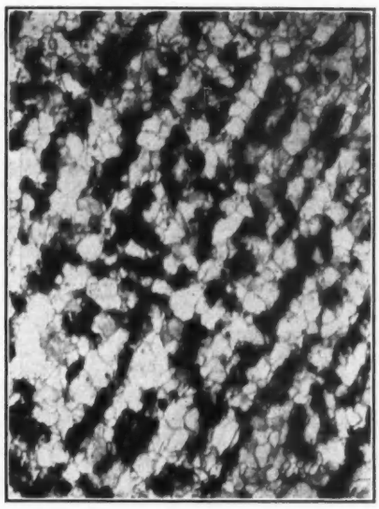


FIG. 4. INSUFFICIENTLY ANNEALED INVESTMENT-CAST STEEL. × 80.

FIG. 5. STEEL AS FIG. 4, ANNEALED AT HIGHER TEMPERATURE. × 80.

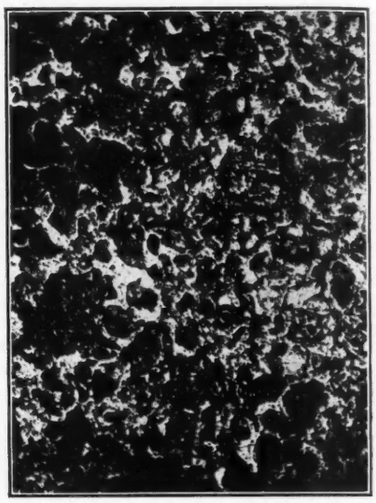


FIG. 6. THE STEEL OF FIG. 5, AFTER NORMALISING. × 80.

obtained in hardened and tempered steel of this composition in the hot-worked form.

The specimens were of the size used for section analysis of large forgings and castings, as this was the only size which the foundry would agree to cast as representative of investment castings in general. The form and dimensions are shown in Fig. 9, on page 167. Annealing and normalising were carried out on the specimens as cast, and the machining operations followed this stage. Machinability was good for both turning and grinding. After hardening and tempering, the diameter over the gauge length and the radii at the changes of section were ground to size.

The tensile tests were made on a Hounsfield tensometer with chart recording mechanism. The results are given in Table III, on this page, and satisfy the requirements of the specification for the wrought forms in respect of the ultimate tensile strength and elongation for six of the eight specimens. A typical curve for the specimens is plotted in Fig. 10, opposite, from which it will be seen that the minimum value for the 0·1 per cent. proof stress has been exceeded. The specification requires that the proof stress shall be not less than 45 tons per square inch, but need only be determined at the option of the purchaser. No maximum value is specified. The two specimens which failed to meet the mechanical properties of the specification were found to have areas of microporosity in the fractured section. There was no evidence of the intercrystalline cracks found in the hardened and tempered specimens, exemplified by Fig. 3.

On the results of the investigation as a whole, it is reasonable to conclude that the tensile properties associated with the composition of the bar material can be recovered by suitable heat-treatment. In so far as the tensile properties are non-directional, they are superior to the forged or hot-rolled bar forms. On the other hand, it is possible, if not probable, that the unworked structure may lack the high resistance to impact and fatigue stresses which fibrous steels possess. Until more positive knowledge becomes available, the use of castings for service involving shock loads or high alternating stresses should be conservative. An obvious conclusion of the tests is the necessity for 100 per cent. radiographical examination, and a rigid rule for rejection of all castings showing evidence of porosity in the stressed sections.

As an alternative to the annealing and grain-refining treatment described above, it may be more convenient and equally efficacious to anneal well above the upper critical point, and to allow the steel to cool fairly quickly to a convenient temperature below the lower critical point and then reheat immediately to a temperature about 20 deg. C. above the critical point. Cooling from this final temperature should be slow. The first stage induces ductility and assists diffusion; the rapid cooling inhibits deposition of massive ferrite in the large grains. The second stage refines the grains and promotes uniform distribution of pearlite and ferrite. It is fair to say that the necessity for this treatment is not recognised by investment foundries for many of the alloy steels which they cast.

Information kindly furnished by the de Havilland Engine Company regarding the tensile properties of three alloy steels is summarised in Table IV, herewith. The properties relating to D.T.D. 666 and D.T.D. 705 have been obtained by closely-controlled hardening treatment, preceded by normalising the cast metal. The values obtained comply with the requirements of the specifications in both cases and accord with the values obtained for the same properties by another aircraft firm, using the same compositions for large castings produced by the centrifugal casting process. Both firms use the same small tensile-test specimen, but in one case the specimens are investment-cast in the standard form and subsequently machined to size. In the other, the specimens are machined from pieces of the actual foundry casting, usually from sections subject to high stress in service.

The castings from which the specimens are cut are in the hardened and tempered condition. Prior to this treatment, however, the castings are annealed at 925 deg. C. for about four hours and cooled in air. The hardening treatment is conventional, but a double tempering operation is preferred. A hardness test is made after the first tempering treatment, which enables the time and temperature of the second treatment to be adjusted to give the desired mechanical properties. Table V, opposite, shows typical results obtained; these should be compared with the values in Table IV and the specification values in Table VI.

The specimens cut from the casting appear to be less ductile on average than the cast specimens, in

TABLE III.—TENSILE TESTS OF CHROME-MOLYBDENUM STEEL SPECIMENS IN FULLY HEAT-TREATED CONDITION.

Specimen Ref. No.	Maximum Stress, Tons Per Sq .In.	Yield Stress, Tons Per Sq. In.	Elongation, Per Cent., 1-in. Gauge Length.	Vickers Hardness and Corresponding Tensile Strength.		Remarks
				V.P. No.	Tons Per Sq. In.	
1	56·0	—	—	280	61·5	Porous fracture.
2	67·5	60	18	295	65·0	Silky ductile fracture.
3	72·0	63·5	17	330	72·5	Silky ductile fracture.
	70·5	63·0	17	320	70·5	Silky ductile fracture.
5	66·5	63·5	16	290	64·0	Silky ring but coarse core.
6	69·0	63·5	18	320	70·5	Silky ductile fracture.
7	70·2	62·0	17·6	320	70·5	Silky ductile fracture.
8	39·0	—	—	290	64·0	Broke at head, very porous.

TABLE IV.—*Mechanical Properties of Investment Castings.*

S.21 Normalised.	Specification.	Ultimate Tensile Stress, Tons Per Sq. In. 28 Min.	0·1 Per Cent. Proof Stress, Tons Per Sq. In.	Elongation, Per Cent. 25 Min.
	November	32·9 32·1	21·1 18·3	34·0 38·0
	October	32·6 33·0	20·5 21·3	40·0 39·0
	September	34·4 34·3	23·9 23·9	32·0 34·0
DTD 666 Hardened and Tempered	Spec.	60 min.	45 min.	12 min.
	December	63·4 63·8	59·6 59·1	20·0 18·0
	November	59·2 59·0	56·4 55·3	18·0 16·0
	October	61·0 60·4	54·0 53·8	16·0 16·0
DTD 705 Hardened and Tempered	Spec.	75 to 82	60 min.	7 min.
	December	76·8 77·0	74·5 73·6	10·0 10·0

ALLOY-STEEL INVESTMENT CASTINGS.

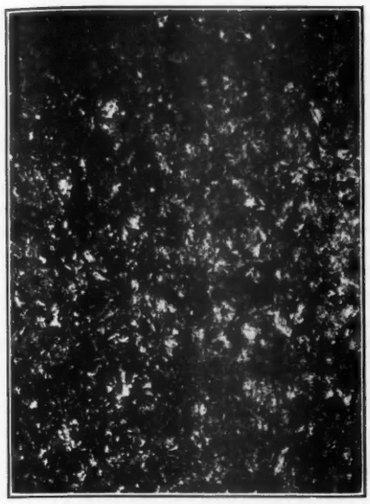


FIG. 7.

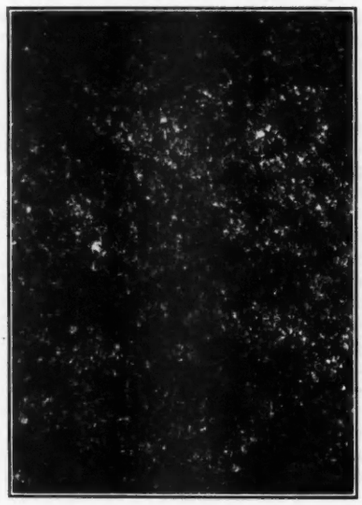
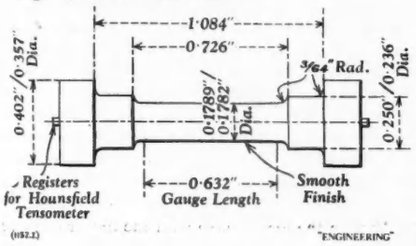


FIG. 8.

FIGS. 7 AND 8. STEEL IN FIG. 4 AFTER HARDENING AND TEMPERING. × 80.

Fig. 9. TENSILE TEST SPECIMEN.



spite of the theoretically sounder metallurgical treatment. The inference is more apparent than real, because the less ductile specimens truly represent sections of the casting which were between

TABLE V.—*Test Results from Centrifugal Casting in D.T.D. 666.**

Specimen Ref. No.	0·1 Per Cent. Proof Stress, Tons Per Sq. In.	Ultimate Stress, Tons Per Sq. In.	Elongation, Per Cent.	Reduction of Area, Per Cent	Izod, Ft.-lb.
1	58·1	65·5	21·8	62·0	—
2	—	—	—	—	44
3	61·0	65·5	22·7	63·7	—
4	—	—	—	—	38
5	65·6	64·2	12·0	30·5	—
6	—	—	—	—	36
7	55·8	64·2	11·0	29·0	—
8	50·5	59·5	8·0	20·2	—
9	58·7	65·5	15·0	43·1	—
10	60·4	66·5	13·0	28·3	—
11	60·0	66·0	12·0	37·8	—
12	60·0	66·2	12·0	36·0	—

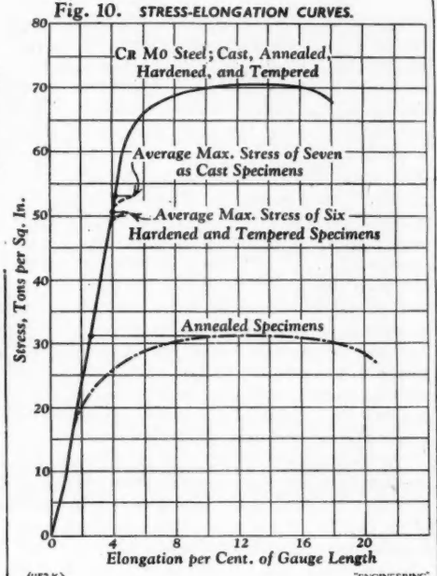
* Table V and related data are from an article on "Centrifugal and Precision Steel Castings for Aircraft," by J. F. B. Jackson, in ENGINEERING, vol. 165, page 484 (May 21, 1948).

TABLE VI.—*High-Tensile Steel Castings for Aircraft; Specified Minimum Mechanical Properties.*

Test.	D.T.D. 666; Specification.	D.T.D. 705, Specification.
0·1 per cent. proof stress, tons per square inch	45	60
Ultimate stress, tons per square inch	60	75 to 82
Elongation, per cent., on $\sqrt{A}$	12	7
Reduction of area, per cent. ..	30	14
Izod, ft.-lb.	30	10

1 in. and 2 in. thick, and therefore take full account of the variation in cooling rates caused by the metal mass. Where the specimens are favourably sited, they are slightly superior to the investment-cast specimens. Moreover, the impact resistance shown by the Izod test results is reassuringly good for a steel casting, heat-treated to this strength.

Fig. 10. STRESS-ELONGATION CURVES.



Some significance may attach to the values obtained from specimen No. 8. This was cut from the centre of the casting mass. It is low in all values, whereas it is generally the case that a low-alloy steel of good structure will compensate for poor ductility by high strength and hardness, or, conversely, reduced strength and hardness will be accompanied by highly ductile properties. It is suggested that this particular specimen is akin in structure to the inadequately annealed specimens of the chrome-molybdenum steel, which has been described earlier in this article. It would probably represent the mechanical properties of the whole casting, had annealing and double tempering been omitted.

It may be accepted, perhaps, that investment-cast specimens of small mass give good mechanical properties in steels primarily designed for castability. It is better, from the engineer's point of view, that forging steels used for investment castings should be given heat treatments likely to provide a sound metallurgical structure. This contention is supported by theory and the results of the investigations here described.

THE INFORMAL WORK GROUP IN MANAGEMENT.

By JAMES J. GILLESPIE.

THE informal group method of works consultation starts first of all with an act on the part of the management which offers each individual in work an opportunity to meet monthly, in company-paid time, in a group small enough to promote individual expression and significance. The stress on the significance of the individual is prominent in the method, because, apart from other social and economic advantages, the need to give each employee a sense of his or her personal significance is of prime importance in these days of collectivist and bureaucratic thinking which classifies persons into masses, classes, workers, miners, managers, engineers, machine-hands, etc. The individual is as unique in character and temperament as in fingerprints, and it is important that this should be recognised as a basic factor in business organisation and control.

When the managing director or other top-ranking executive offers each individual in his company paid time in which to meet, he makes practical his belief that each individual is potentially a responsible person in work. Especially important is the change in status of those individuals who meet, for the one who meets in an informal group is no longer merely a worker who is paid wages for output; he or she is a person, acting as such. This change of status is of more profound import than appears at first, as is the status change of members of the management hierarchy. "Management" is not a body of ruling people or an applied method; at human level, it is a relationship between individuals of different power and status, and a change in the status of the managed is bound to lead to a change in the status of the managers concerned. It is this inter-related change which is likely to lead to a solution of the problem of manager-worker relationships, and also that of worker apathy, and antagonism in and towards work.

GROUP ORGANISATION.

The three companies who have had experience of informal-group operation for more than one year are Best and Lloyd, Limited, of Birmingham; Carter and Company, Limited, of Poole, Dorset; and the Aston Chain and Hook Company, Limited, Birmingham. These companies are in their fourth, third and second year of group experience, respectively. In all three, the method is nearly the same in the following respects:

Group membership averages about 12, and ranges from seven to 18 persons.

Individuals and groups are free to meet or not as they wish, and to choose their own topics for discussion.

The groups are each invited to appoint a chairman and a secretary, and to keep minutes of their business.

Group minutes are published in a monthly communications journal, together with the minutes of some kind of executive group on which lower-level groups are represented; the names of individuals attending group meetings are published in this journal.

There are groups for foremen and chargehands, and for office staff.

The members of any group are of somewhat similar status level and perform similar or related functions; that is, no managers attend group meetings without invitation. Group members are usually in geographically close work relationship.

It is sometimes said that the essence of consultation in work is that managers and men should meet; but what if the men and women prefer to meet by themselves? In my experience, no single group has at first chosen to have any kind of

managers at group meetings, and that, in my opinion, is a clear indication of the state of work relationships. With patience on the part of the managers, and no manipulation, the groups will begin to ask for the attendance of this and that executive functionary.

Managers may put problems and projects to the groups, and the groups have the unquestionable right to reject discussion of these problems and projects. In fact, groups are willing and eager to discuss projects put to them by managers.

Day-to-day liaison between the groups, and between groups and members of the executive hierarchy, is undertaken by a full or part-time personnel welfare worker who, in each of the three companies mentioned, is democratically elected by the body of operatives, foremen and office workers after being passed as technically fitted for the job by the managing director. This method, which may not be an essential feature of the group method, was first tried by Mr. N. I. Bond-Williams, of the Aston Chain and Hook Company. No one of the individuals doing the job chose to use the names "personnel officer" or "personnel manager," as the job is neither to officer nor to manager.

The Method in Practice.

At the works of Best and Lloyd, Limited, and of Carter and Company, the groups meet for one hour per month; at the Aston Chain and Hook Company, they meet for half an hour per month. Best and Lloyd, Limited, have a management board with Mr. R. D. Best as chairman, and with sales, technical, and financial representation, and one member appointed from each of the production, office and foremen groups. At Carter and Company, there is an executive group within each of the two works, with Mr. H. R. Hidden, the general manager, as chairman. At the Aston Chain and Hook Company, there is a meeting of all group leaders once a month; this includes office and foremen groups. There is also a junior board on which the personnel welfare worker represents the groups.

One important aspect of group work is that the method seems not to work well when the operating unit comprises more than 400 individuals; if the unit is larger, the individual and the groups lose significance, do not see the company objective clearly, and relationships are less vital. Thus, at Carter and Company, which consists of several tile and pottery and related works, the managing director, Mr. C. C. Carter, chose to have two adjoining works as separate units for group purposes; each unit has its own executive group and its own monthly communications journal.

The most important effort to solve the problem of manager-worker relations is the Joint Council, and it is perhaps unfortunate that, in many instances, the council method seemed to fail when it could have been vitalised by a downwards extension in the direction of informal groups. In some companies, the joint council method still does good work, but it is generally admitted that the method does not bring in the individual worker at the bench, machine and desk; indeed, in some cases there is marked apathy towards council proceedings and council elections. Also, there is a tendency to equate the spirit of a council with the spirit on the workshop floor; in my analyses in a number of companies, I have never found more than, at best, some mild acquaintance with council matters, and there has been much ignorance.

It is said that the problem of making the joint council work is one of communication. It is that; but it is also much more, of even greater importance. The problem is one of including every individual in work in the actual consultative procedure in a situation where the individual is free to express herself or himself. This can be done very effectively by using the small informal groups as the basis of the council; two prominent manufacturers who have active joint councils in their works intend to do this. Some administrators will not feel a need for worker participation in company affairs because theirs is a "good" works where behaviour is good. I think we should distinguish between good behaviour and responsible behaviour; the former may be a product of apathy or of convenience.

Two-Way Communication.

The informal group system is not merely a communication system between aggregates of different status and power; the informal group meeting aims at communion and communication between persons. The communications from the groups are sometimes bitter and critical at first, and, to meet this, some maturity is required in managers. Even in a "good" works, a release of suspicion and distrust is almost inevitable at the beginning of the informal group project; to many, this is proof of the superiority of the method over methods which are trouble-free, but to some managers it is a terrifying prospect. There is an appalling ignorance of the management's task among the rank and file, and it is not without humour when a group solemnly affirms that "the management is inefficient," or "we are carrying too many non-producers." In passing, the offering of education in the significance of the management's task is part of the group project, and a much-needed one; the informal group will welcome illumination on the managing function.

The two-way process begins when the managing director, through his managers, treats his employees as potentially responsible by offering them paid time in which to meet; and this large and thoughtful act leads inevitably to a return flow of respect to the managing director and his managers. This is easily detected in practice, even when, as is usual, it is mixed with a strong suspicion of the aim in view. Moreover, projects flow from the managers to the groups. Thus, at Best and Lloyd, Limited, the groups share in nearly all major business projects at factory level and, in passing, actually make a works canteen pay. At the Aston Chain and Hook Company, the group spend some 3,000*l.* a year on welfare and similar services, and are now completing a revision of the works rule book. At Carters', the executive group put a major work problem each month to the groups. To meet any argument that workers are incapable of taking responsibility, here is a verbatim quotation from the recent minutes of a group made up of women and girls:

"*Enamel Faults Report.*—The number of chips was discussed and one instance of some badly chipped tiles that were glazed was brought to the attention of the Group. It was agreed that great care would be taken that this didn't happen again.

Bits in Face.—The Group wishes to state that all precautions against bits are taken *by this Section*, such as beating out cranks, etc., so perhaps the cause is elsewhere!!

Knocks and Rubs.—It was felt that the majority of these were caused by the fact that a large number of the smaller size tiles, such as Z size to S4 sizes, are being glazed lately; some of these remain damp for a considerable time after glazing, which makes them much more easily damaged.

Firing Position Marking.—Could it be impressed on all concerned that, when a setter on which the firing position of a stack of tiles is marked has to be removed, care is taken in seeing that the correct one is put back? It was stated that recently there were some tiles awaiting firing with several different firing position markings that had apparently been put there after other tiles had been removed. It was pointed out that this could cause shading by confusing the firing positions."

It is worth consideration that the capacity to take responsibility for and with others is not so much a matter of intellectual standard as it is of feeling; the individual with a high intelligence quotient is often egocentric and on a plane of feeling that is isolated from other people.

Of course, groups talk nonsense sometimes and discuss what seem to be trivialities; but the important thing is that they do participate, and every item of discussion is a peg on which thoughtful managers will hang the flag of good teamwork.

The Role of the Foreman and Manager.

It was said earlier that, when the managing director gives his people paid time in which to meet and think, an important change of status takes place among the workers. We know that, in society, the individual is a responsible citizen, but that in his work he is a managed and organised worker; it will be seen, perhaps, that the change of status mentioned heals the breach between work and social life.

The change in the status of the foreman and manager when informal groups operate is clear to all who are closely connected with the group method. When the administrator allows these informal meetings, with free criticism of himself and his associated managers, he and they experience a change in status from that of imposed headmen to that of leaders; for the only true leadership in an organised institution is that which is open to free criticism through channels accepted by the leaders of the institution. It may be said that, in many businesses, such channels exist; this is true, but the individual is not given paid time in which to be a critic and creator.

Broadly, there is first a flow of respect to the top administrators from the groups, and, at the same time, an acceptance of the need for foremanship, with increasing support for the foreman from the groups. The foreman feels more secure as a person, in that there is a removal of conflicts; it is for this reason, perhaps, that a large majority of foremen accept the informal group system where it operates. There is, too, less reluctance among promising workers to take staff posts.

As with the foreman, so with the higher manager as time passes; but the higher manager who wishes to have successful groups in his business must be a fairly mature person, for to have informal groups is an exercise in the important art of not managing others. The aggressive, insecure type of manager is unlikely to initiate groups that are really informal. Also, managership should be technically effective, and able to be firm when circumstances demand. Managership which is technically weak or is lacking in courage to apply necessary disciplines receives small respect from the groups, as will quickly be found. It will be seen that a very great deal depends on the quality and characteristics of managership where the group system operates; this is true where there is no group system, but—and this is evident to the close observer—immature, inefficient and weak managership creates anxiety among group members and they show considerable concern about it.

To repeat, the informal group method is, primarily, a management act which recognises the dignity and significance of the individual employees and brings them forward into the business picture; that is the ethic of the method. Its social aspect lies in the significant change of status of the people within the works. The economic fruits of the method—and there are many excellent fruits—are a by-product. Paramount in the process is the quality of the contribution made by members of the managing hierarchy.

Aerial Survey of Railway Tracks.—The Western Region of British Railways are employing aerial photographic surveys to obtain up-to-date information, in plan form, of sections of railway track. By this means revised plans are being prepared with great accuracy of detail to a scale as high as 40 ft. per inch. The section of line between Barnstaple Junction and Halwill Junction, Devon, is now being photographed by Hunting Aerosurveys, Ltd.

HYDRAULIC TORQUE-GENERATING SPANNER.

ACRATORK ENGINEERING CO., LTD., CARDIFF.

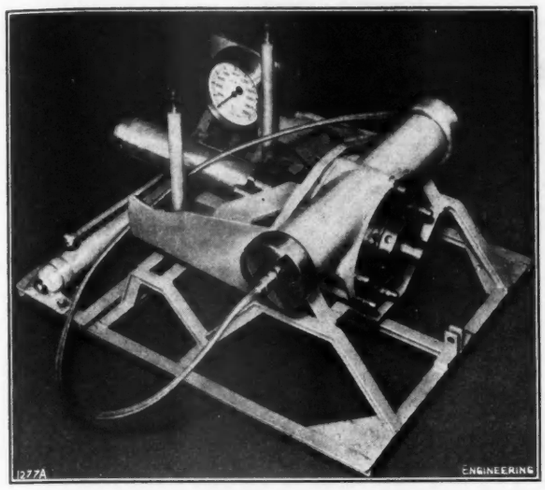
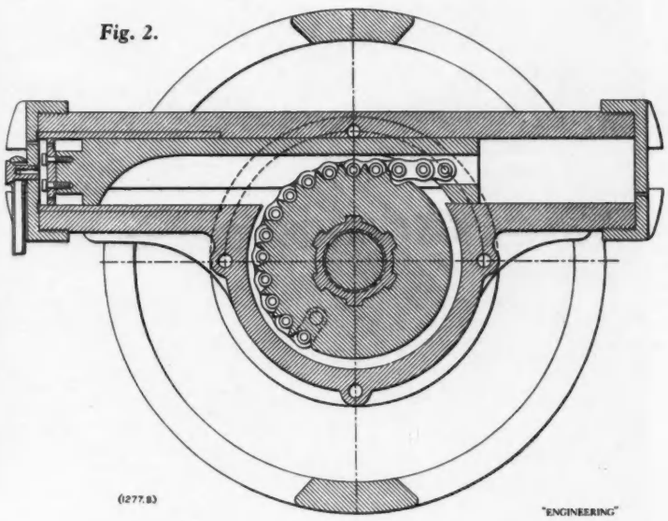


FIG. 1. TORQUE GENERATOR AND PUMP IN CRADLE.

Fig. 2.



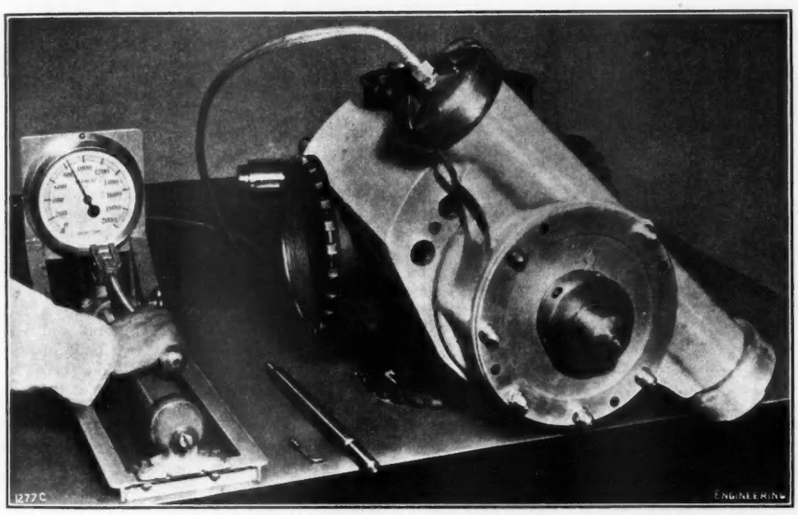


FIG. 3. SPANNER APPLIED TO AIRCRAFT PROPELLER HUB.

HYDRAULIC TORQUE-GENERATING SPANNER.

THREE new tools for tightening nuts, hubs, etc., which have been developed by the Acratork Engineering Company, Limited, Cory's Buildings, Cardiff, are a hydraulic torque generator for applying very high tightening torques, and two hand torque spanners to add to their existing range—a miniature model for loads up to 36 lb.-in. and a large one for loads of 500 lb.-ft. The hydraulic torque-generating spanner, which is illustrated on this page, was developed originally for accurately tightening the hub nuts on aircraft propellers, but it will be suitable for many other applications where a torque of up to 2,000 lb.-ft. is required. It may, for example, be used for tightening large nuts on bridges and other structures. It is portable and the torque being applied is readily controlled. Fig. 1 shows the equipment in a cradle; it comprises the torque generator, a hand pump, and a pressure gauge graduated in lb.-ft. of torque. The construction of the generator is shown in Fig. 2, and Fig. 3 illustrates the application of the equipment to an aircraft propeller hub, which is shown on a table for convenience in photographing.

Oil under pressure is delivered from the hand pump to one end of the horizontal cylinder shown in section in Fig. 2. A piston is thereby moved along the cylinder, and its linear motion is converted to rotary motion by means of a chain which is connected at one end to the piston and at the other end to a sprocket around which it lies. The piston has a groove milled in it to clear the sprocket and chain. A Lion twin packing which is fitted to the pressure end of the piston is not shown in Fig. 2, though the groove which it occupies is visible. The sprocket runs in two ball bearings in the housing and is splined to a hollow shaft which carries a form of box spanner or other device to engage the nut, hub, etc., to be tightened. When the appliance is used for propeller hubs, the splined shaft is provided with a rotatable spigot which fits inside the propeller shaft and ensures that the appliance is correctly lined up with the propeller-hub nut. This rotatable spigot has a rounded nose and is free to turn on two ball bearings which are secured to an extension of the splined shaft. Torque reaction when tightening a nut is taken by two arms which press on two of the propeller-hub bosses; one of these arms is visible in Fig. 3 and two are shown in section at the top and bottom of Fig. 2. For other purposes a different design of reaction arms could be used.

Normally, the hydraulic spanner is used for tightening nuts with left-hand threads, but it can readily be arranged for tightening left-hand nuts. Four nuts and a lock nut holding the housing to the reaction arms are removed and the housing, including the cylinder, piston, etc., is turned about and the nuts replaced. The shaft is also turned about. Whenever the hydraulic spanner has been used, the piston is returned to the initial position by inserting a tommy bar in the rear end of the shaft and rotating the shaft in the direction opposite to the applied torque. The pressure-gauge graduations, though they are marked in lb.-ft. of torque, are also in fact graduations in lb. per square inch of the pressure on the piston, the proportions of the piston, sprocket wheel, etc., having been deliberately designed for this purpose. This feature would be useful if the gauge supplied with the equipment were damaged, since it would then be a simple matter to replace it by a standard pressure gauge. Moreover, the gauge is readily checked by a dead-weight test as there is no need to take into account a conversion from torque to pressure. The hydraulic spanner shown in the illustrations is the prototype model; the production design will have the pump incorporated in the main unit.

The new torque spanner of 500 lb.-ft. capacity follows the same design as the existing Acratork range, but it is larger to take the increased load without distortion or undue stress of the working parts. The spanner is suitable for all applications where there is space for sufficient leverage for manual operation. Development work is proceeding with a view to bringing within the range of this spanner torque loads of up to 1,000 lb.-ft. The overall length of the spanner is 4 ft., and provision is made for the insertion of a tube into the handle to give added leverage, when necessary, for the higher torque loads.

The miniature spanner is designed for repetition work on assembly lines in light industrial and similar applications. Although it is designed on the same cam-operated principle as the standard Acratork spanners, the miniature model differs in that it operates on a flat cam and, as the cam and spring housing form the handle, it can be operated conveniently in a confined space. The makers claim that the miniature model, like their other torque spanners, cannot be overloaded and therefore retains its accuracy for long periods of continuous operation within the recommended torque range of up to 36 lb. per square inch.

INSTITUTION OF PRODUCTION ENGINEERS.—Sir John Cockcroft, C.B.E., F.R.S., is to present the Sir Alfred Herbert Paper for 1953 at a meeting of the Institution of Production Engineers, to be held in the Sheldonian Theatre, Oxford, on Friday, July 24. His subject will be "Industrial Applications of Atomic Energy."

FLIGHT AND RESONANCE TESTS OF THE "BRITANNIA" AIR-LINER.

BRISTOL AEROPLANE COMPANY, LIMITED, BRISTOL.

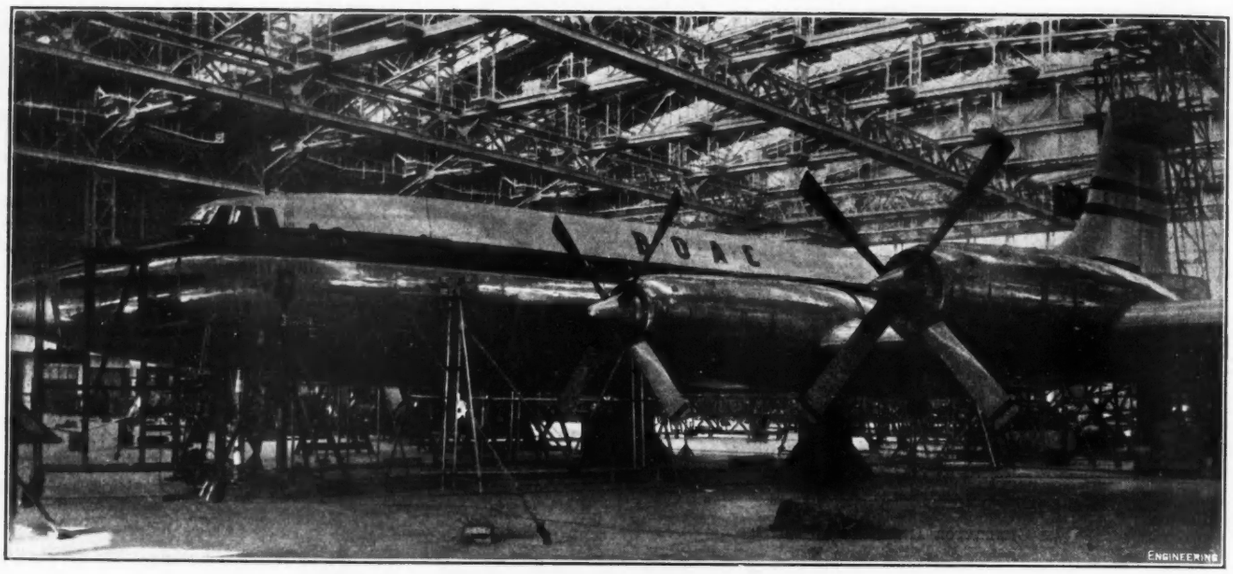


FIG. 1. THE PROTOTYPE AIRCRAFT UNDERGOING RESONANCE TESTS.

FLIGHT AND RESONANCE TESTS OF THE "BRITANNIA" AIR-LINER.

THE Bristol Aeroplane Company, Limited, Filton House, Bristol, have issued a progress report on the prototype Britannia air-liner, which has now completed the first phase of its flight trials. The Britannia air-liner is on order for British Overseas Airways Corporation, and flew for the first time during the summer of 1952; a description of the aircraft was given on pages 245 and 257 of our 174th volume (August 22 and 29, 1952). Up to the present, the Britannia has completed 48 flights with a total flying time of 46½ hours. No serious trouble has been encountered, and the company report that they are satisfied that the basic capabilities, flying qualities, and fitness for the designed purpose have been proved.

So far, only preliminary performance measurements have been made, which indicate that the lift and drag characteristics agree with the estimated values, in some respects showing an improvement. It may be recalled that the Britannia is not fitted with powered flying controls, but that the main control surfaces are actuated aerodynamically by servo tabs operated by the pilot. This system has proved to be most effective, and in the case of the elevator controls it has been found to be desirable to reduce the sensitivity by cutting down the horn-balance area and changing one of the tabs from servo to trimming duties. The aircraft has been flown at weights up to 125,000 lb. (the maximum permissible weight of the prototype Britannia is 130,000 lb.) and at centre-of-gravity positions ranging from 12 per cent. to 35 per cent. of the mean chord. At the aft limit of 35 per cent., which is well beyond what would normally be used, the aircraft could be controlled satisfactorily. A satisfactory landing has been made at a weight of 120,000 lb., although the landing weight of the prototype aircraft is normally limited to 105,000 lb.

The prototype aircraft is fitted with four Bristol Proteus 625 propeller-turbine engines; the second prototype and production aircraft will, however, be fitted with the more powerful Proteus 705 engines. With the Proteus engine, the propeller is driven by a separate turbine which is not coupled to the compressor. The flight trials have shown that, with an engine cut out of action immediately following take-off, the propeller drag is much less than if it were coupled to the compressor, and the swing resulting from asymmetric power is easily held even before the propeller is feathered. Three-engined landings have also proved to be straightforward. Re-lighting tests have been carried out satisfactorily at various altitudes.

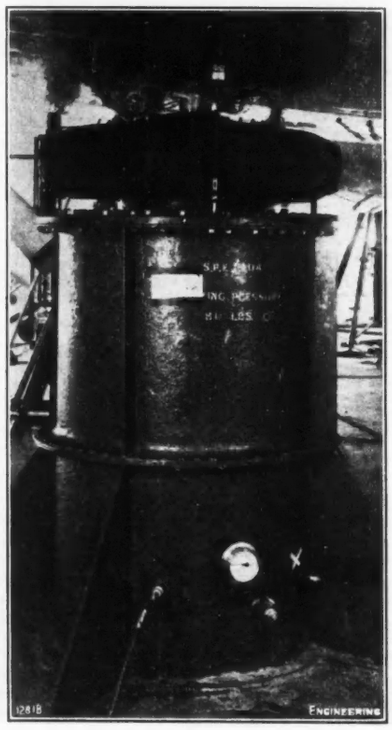


FIG. 2. LOW-FREQUENCY SUPPORT.

The approach speed of the Britannia is not critical within a range of about 20 knots. The angle of the glide path can be varied within wide limits; if the full 50-deg. deflection of the flaps is used, a very steep glide path can be adopted. The handling trials have included power-off stalls over a wide range of conditions. The stall is gentle, with no pronounced tendency to dropping a wing, and a definite warning is experienced at the approach of a stall.

After the primary phase of flight testing was completed, the prototype Britannia was returned to the assembly hall for resonance tests. For these, the aircraft was supported by a low-frequency nose sling, suspended from one of the overhead cranes, incorporating a cam-operated spring, and on two low-frequency supports placed at the main jacking points, as shown in Fig. 1. These supports, one of which is shown in Fig. 2, were designed by the company, and consisted of a tank of large volume providing an extremely low degree of damping, the frequency of the mass mounted on the tank depending on a small change in volume. On top of the tank, a nitrogen-filled tyre provided a flexible mounting for the aircraft. Lateral and vertical vibrations were produced by two pairs of moving-coil exciters, mounted on the floor beneath the nose of the aircraft and driven by a Bristol low-frequency generator. The vibration frequencies at various pick-up points on the aircraft structure were transmitted to a control van. The resonance tests have now been completed and the aircraft will shortly enter on the second phase of flight testing.

Meanwhile, work on the second prototype, which will be completed up to normal production-aircraft standard, is proceeding according to schedule, and it is expected to fly this summer. The all-up weight will be increased to 140,000 lb. The first production aircraft has now reached the final-assembly stage, and the fuselage of the second production aircraft is ready for delivery to the main assembly hall. Both these aircraft are expected to fly early in 1954.

RECORD IRON OUTPUT.—The blast furnace at the Dagenham works of the Ford Motor Co., Ltd., has produced 1,553,766 tons of iron, without relining, in eight years three months. The furnace, which is stated to be the only blast furnace in the south of England, came into operation in 1934, and during the past 19 years it has produced well over three million tons of high-quality iron.

ALUMINIUM DEVELOPMENT ASSOCIATION DIRECTORY OF MEMBERS.—A new edition of the *Directory of Members* of the Aluminium Development Association, 33, Grosvenor-street, London, W.1, has been issued. It contains the names, addresses and other information respecting its member companies, together with particulars of their associate and subsidiary firms, where applicable. In each case, a short description is given of the activities and products of the affiliated organisations. By means of an index of products, classified under aluminium and aluminium alloys, readers are referred to all member companies producing specified products. Copies of the directory are obtainable from the Association free of charge.

THE ECONOMICS OF ROAD TRANSPORT IN THE UNITED STATES.

TENTATIVE programmes have been prepared recently for an extensive investigation which, it is hoped, will lead to a determination of the most economical ranges of size and weight of lorries and other road-vehicle combinations to transport freight on the future highways of the United States. The investigation is to be made by a committee sponsored by the department of Economics, Finance and Administration of the Highway Research Board in Washington, D.C. It will cover both the running costs and load capacities of the vehicles themselves, as well as a study of highway facilities that will include both road construction and maintenance. In substantiating the need for the investigation, it was pointed out that, in the movement of freight by road, the overall cost to the ultimate consumer includes both the capital and running costs of the vehicles and the costs of providing the highway facilities on which the vehicles are operated. In the economic system of the United States, the ultimate consumer of any particular item of freight pays all the transport costs of that particular item, partly as direct charges for vehicle service and partly as an indirect charge for highway facilities.

The committee defined their task as the determination of the optimum type, size and weight of freight vehicle that can be employed on pavements and bridges of existing or proposed capacities to produce the lowest overall cost of freight transport by road. Results of earlier studies show that, as the load capacities of pavements and bridges are increased, the costs of both road construction and road maintenance increase, but the trend and limits of such increasing costs, in terms of the cost of the freight transported, have not yet been investigated. On the other hand, it is known that, as the size and weight of the vehicles are increased, their operating costs decrease for each unit of freight transported; the trend and limits of these operating costs, likewise, have not been fully investigated. The committee recognise that their task will be to determine the best compromise between these two conflicting cost trends.

The investigation has been divided into two parts. One part will be concerned with commodity density (in respect of both place and season), packaging methods, market units and transport tonnages to determine the optimum payloads for those commodities the annual production of which is of such a magnitude as to be significant to the economics of the country as a whole. It is of paramount importance that these materials shall be transported at the lowest practical overall cost. An allied phase of this aspect of the investigation will be to study the variations in both overhead and direct costs of vehicle operation as the size and gross weight of the vehicle are increased; as noted above, it is already known that operating costs decrease with increasing vehicle size, but it is believed also that this saving in direct operating costs diminishes progressively with increasing vehicle size. Such a trend indicates that there is an upper gross-weight limit beyond which reductions in vehicle operating costs cannot be achieved by merely increasing the gross weights of vehicles. In the course of their study, the committee intend to examine the costs relating to vehicle combinations with a gross weight of 35,000 lb. and upwards.

The second part of the investigation, which will not be started for some time, is a study of the relative and actual costs of highways with differing load capacities. At present, research on this aspect of the problem is sponsored by the American Association of State Highway Officials. The Western Association of State Highway Officials, with the co-operation of industry, is already collaborating with the Highway Research Board of the National Research Board on a full-scale test on a series of flexible pavements at Malad, Idaho. In Illinois, the same organisations are planning a second full-scale road test which will be concerned with pavements of both rigid and flexible construction. In both these tests, tractor trailers with differing axle-loads are to be run repeatedly over sections of pavement to determine the effects of specific loads on pavements of a particular design. From such tests, it is hoped that it will be possible to abstract cost data which can be used in conjunction with the information from the first part of the committee's investigation to predict the optimum size of vehicle to provide minimum overall road-transport costs in the future.

The Highway Research Board committee is composed of representatives of the State highway departments, planning and survey departments, and other Government agencies interested in road-transport problems, together with the vehicle makers, road-haulage contractors and trade associations. Mr. Herbert S. Fairbank, deputy commissioner in charge of the Research Division, Bureau of Public Roads, United States Department of Commerce, is to be chairman of the committee. The secretary of the committee will be Mr. H. Stevens, also of the Bureau of Public Roads, who will be responsible for the direction of the field work in both parts of the investigation. The address of the secretary is Department of Economics, Finance and Administration, Highway Research Board, 2101, Constitution-avenue N.W., Washington, D.C.

EXPANSION OF IMPERIAL COLLEGE FOR HIGHER TECHNOLOGICAL EDUCATION.

THE Government have reached a firm and promising decision on the problem of developing higher technological education in this country. In September, 1951, the Labour Government proposed to deal with the question by establishing a College of Technologists, which would have the right to confer fellowships for distinguished work and admission to membership of which would be by examination. This proposal was criticised by us at the time; and in subsequent correspondence in our columns it was stigmatised as likely to do illimitable harm to the science and profession of engineering and to the prestige of the engineer. That danger was, however, avoided by the announcement of the present Government in June last, that they proposed to build at least one institution of university rank, in which predominance would be given to the teaching and study of various forms of technology. Now, according to a statement made by the Financial Secretary to the Treasury (Mr. J. A. Boyd-Carpenter) in the House of Commons on Thursday, January 29, this policy is to be implemented by a method of compromise.

Mr. Boyd-Carpenter said that the Government had decided to provide facilities for increasing the number of full-time students at the Imperial College of Science and Technology from 1,650 to 3,000 during the period 1957-63, and that the additional buildings necessary for that purpose would be erected round the existing site in South Kensington. In addition, resources are to be made available for corresponding developments in other parts of the country, and the University Grants Committee have been asked to say where these resources can be most usefully "deployed." The Minister added that these projects would be supplementary to those which are already in progress. It may be recalled that the Imperial College, which was established by Royal Charter in 1907, is a federation of the Royal College of Science, the Royal School of Mines and the Central Technical College. It already provides the highest specialised instruction in various branches of science, especially in its application to industry, and as a school of the University it enables students to avoid the risks which may arise from over-specialisation. The proposal will therefore be welcomed and the results will be awaited with interest.

AIRCRAFT INDUSTRY'S EXPORTS DURING 1952.—Exports by the British aircraft industry have expanded steadily since the end of the war; in 1952 they amounted to 43,933,539*l.*, compared with 41,955,652*l.* in 1951. The highest monthly value for exports ever recorded, 4,500,000*l.*, was in December, 1952. It is expected that still higher values will be reached in future years with increasing overseas sales of turbine-engined air-liners, which have only recently commenced.

REORGANISATION OF A DIESEL ENGINE WORKS.

A BOLD decision taken a few years ago by Mirrlees, Bickerton and Day, Limited, to concentrate their Hazel Grove Works, Stockport, on the production of Diesel engines of only two basic cylinder sizes is now resulting in the expected advantages—reduced production costs, increased output, and, consequently, a greater ability to retain and capture markets, especially overseas markets. The reorganisation of the works to suit the two basic designs is nearing completion, and by the middle of this year the output of Diesel engines is expected to be at the rate of 2,500 h.p. a day—the highest rate, it is claimed, for a Diesel-engine works in this country. Even while the reorganisation has been in progress the production rate has multiplied: in 1945 it was 675,455*l.*, last year it was approximately 4,250,000*l.*, and this year production at a rate of 6,000,000*l.* is planned. The number of employees has simultaneously increased—though not as much in proportion, since the output per man has been doubled; there are now 1,650 employees, compared with 650 in 1946.

ENGINES OF TWO BASIC CYLINDER SIZES.

The two types of Diesel engine for which the factory has been reorganised are the "J" and the "K," which are made in both the in-line and V-form. The J series have a 9¾-in. bore and 10½-in. stroke; they run at speeds up to 1,000 r.p.m., and are built in a number of sizes from 3 to 16 cylinders, covering a power range of from 165 brake horse-power to 2,500 brake horse-power. These engines are being supplied in large numbers for marine propulsion, marine auxiliary duties, industrial purposes, Diesel-engine traction, Diesel-mechanical traction, and oil-field drilling rigs. They are suitable for this wide range of applications because of their short piston stroke, which permits of high revolutions per minute without an increase in piston speed. The J design was described in ENGINEERING, vol. 168, page 503 (1949), and a summary of the main features is given at the end of this article. The K engine also has a short stroke—18 in., compared with a bore of 15 in.—and for a Diesel engine of this cylinder size it runs at a comparatively high speed, namely, up to 450 r.p.m. With the K design, there are engines of from 5 to 12 cylinders, developing from 485 to 3,000 brake horse-power. They are particularly suitable for power-station and marine-propulsion duties, and their fuel consumption is stated to be remarkably low. The prototype K engine was described in ENGINEERING, vol. 169, page 151 (1950), and the design of the largest of them is now shown in the cross-section and part longitudinal section reproduced in Figs. 6 and 7, on page 173. A summary of the main features of this design is also given at the end of the article. Fig. 1, on page 172, shows the control end of one of the in-line K engines.

REORGANISATION OF THE WORKS.

The works which has now been reorganised was first used by Mirrlees, Bickerton and Day, Limited, in 1908, the year that Mr. Charles Day joined forces with Mr. H. N. Bickerton. The firm had already made a name as Diesel-engine builders; indeed, they had built the first Diesel engine in this country (the third in the world) in November, 1897, and had provided the first Diesel engines to be used for auxiliary purposes in a naval vessel. In 1912 they built the first Diesel-electric unit for ship propulsion, and in subsequent years they were responsible for some of the earliest industrial installations of Diesel generating sets. The firm is now one of the companies in the Brush A.B.O.E. Group, and its works stands on a site of 250 acres with virtually unlimited room for expansion.

The revised layout and flow diagram for the works are shown in Fig. 2, on page 172. On a visit to the works last week we saw the new organisation in operation, though, as there are still a few new machine tools to be installed and a number of other tasks to be completed, it was not possible fully to appreciate the significance of the change. That it is significant, however, is apparent from the figures

of increasing output already given. The orders now in hand total over 12,000,000*l.* in value, which at the present rate of production is equivalent to over two years' work. However, as some of these orders are not required to be completed until 1955, additional orders for delivery in 1954 are still being undertaken.

Castings, forgings, crankshafts, etc., are bought out. Thus the works comprises mainly machine shops (light, general and heavy), sub and main assembly shops, test beds, a packing shop, stores, tool room, fettling shop, etc. The main offices are on the south side, as shown in Fig. 2, with direct access into the works. The perimeter road which runs right round the works provides quick and ready entrance and exit for goods entering and leaving. As shown in Fig. 2, there are doors at the north ends of bays 2, 3A, 11 and 13, as well as at several other places round the building. Materials and components coming into the works flow, in general, from north to south, passing first through an inward-goods department like that in bay 3A. Here, the staff in the adjacent office can readily see through the window overlooking the bay, and can therefore exercise effective control over the flow and progressing of the goods at this stage. The main flow of bars, tubes, etc., entering the works at the north end of bay 2, is through the stores, to one of the machine ships, then to the stores, or to the hardening shop, or on to the sub-assembly department. Heavy castings, having entered at the north end of bay 11, are there prepared for machining, being fettled and marked off as required, and are then sent to the heavy machine shop. A general indication of the various flow lines is given in Fig. 2. It will be seen that the work proceeds northwards to the sub-assembly shop; from there it passes to the main assembly shop in bay 10; and moving southwards and then westwards the engines arrive at the test beds in bay 14. Fig. 8, on page 176, shows columns for a JV engine partly assembled.

Machine Tools and Plant.

Since 1946, it is stated, almost 90 per cent. of the machine tools and equipment of the works has been renewed. Some of the most interesting machine tools are shown in Figs. 3, 4 and 5, on Plate III, and in Figs. 9 to 11, on page 176. The Asquith double-head angle borer (Fig. 3) was specially designed to bore the main housings for the cylinder liners for both in-line and V-engines. The heads are permanently set at an angle of 22½ deg. to suit the Mirrlees V-engines, and when in-line cylinders are to be machined they are mounted on wedge-shaped blocks to bring the cylinder axis in line with the boring-head axis. This machine bores the housings to a considerable degree of accuracy at an all-in average rate of 90 minutes per cylinder. It has a bed 37 ft. long and it weighs 88 tons. The Gildemeister plano-miller shown in Fig. 4, on Plate III, has been installed for machining the faces of in-line engine columns, and the Kendall and Gent plano-miller illustrated in Fig. 5 is used for machining the columns of V-engines. Three Alfing machines are shown in Figs. 9 to 11. They are, respectively, a piston lathe; a bedplate borer which achieves an unusually high rate of production, reduces the fitting time required for bedding the crankshafts and improves the quality of the finish; and a piston-boring machine, one of two which can machine the J-engine pistons faster than any known method. A Fischer profile-turning lathe has also been installed to machine the through bolts of the K-engines; it carries out the work in a quarter of the time required by the old method.

The recent extensions to the factory have been in the northerly direction. All bays except one have travelling overhead cranes and the best use is made of the available floor space (300,000 sq. ft.) by placing static equipment between stanchions, clear of the crane-covered area. All heavy machines are situated in the bays with the greatest headroom to facilitate the handling of large components. Electric jib cranes are fitted to stanchions throughout the works, thus enabling components to be passed from machine to machine with a minimum of fatigue. Pallets and stillages are used for small components and are transported by battery-driven hand and fork-lift trucks. Except in the case of

PRODUCTION OF DIESEL ENGINES.

MIRRLEES, BICKERTON & DAY, LTD., STOCKPORT.

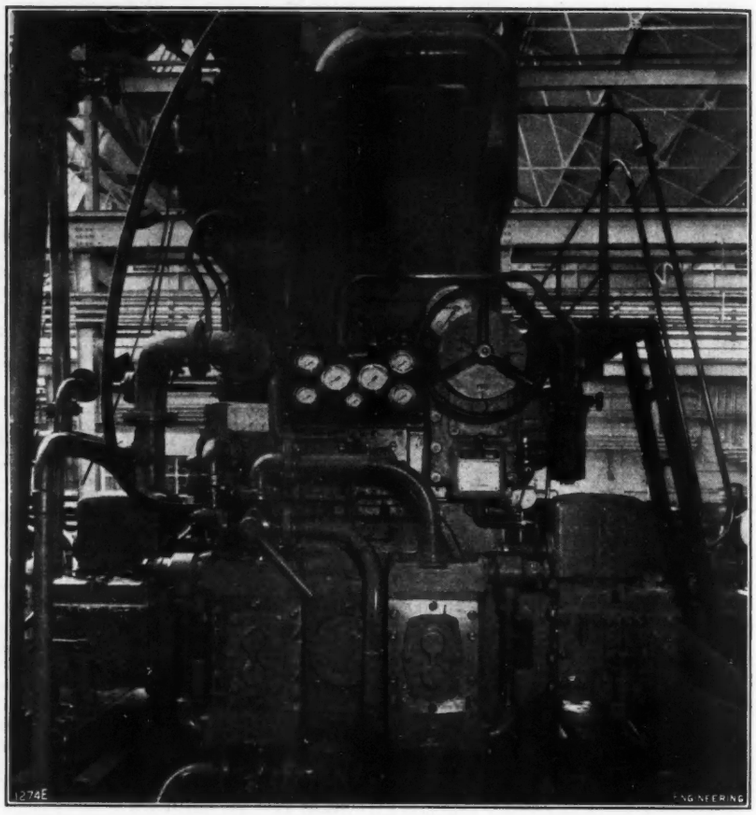
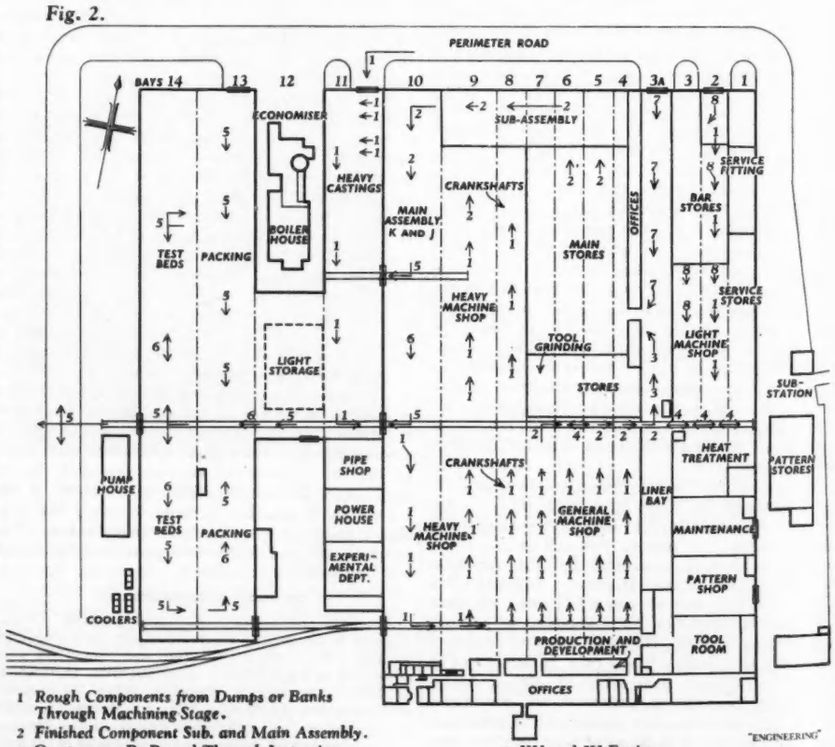


FIG. 1. CONTROL END OF K-TYPE IN-LINE ENGINE.

Fig. 2.



1 *Rough Components from Dumps or Banks Through Machining Stage.*
2 *Finished Component Sub. and Main Assembly.*
3 *Components By-Passed Through Inspection.*
4 *Components By-Passed Through Hardening Shop.*
5 *K and J Engines.*
6 *KV and JV Engines.*
7 *Bought-Out Finished Parts.*
8 *Bar Components, Tube and Bar Materials.*

(To face page 172.)

HEAVY MACHINE SHOP AT A DIESEL ENGINE WORKS.

MIRRLEES, BICKERTON AND DAY, LIMITED, STOCKPORT.

(*For Description, see Page* 171.)

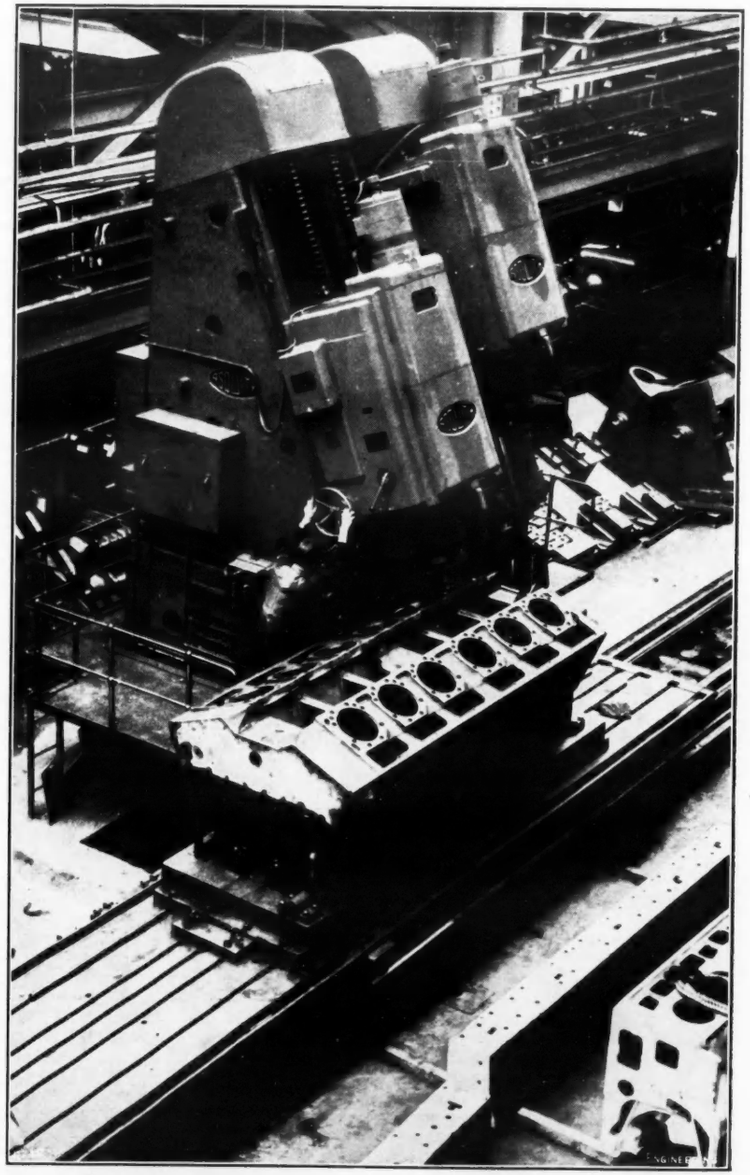


FIG. 3. ASQUITH TWO-HEAD ANGLE BORER.

FIG. 4. GILDEMEISTER FOUR-HEAD PLANO-MILLER.

FIG. 5. MACHINING CYLINDER HOUSING ON KENDALL AND GENT PLANO-MILLER.

2,484-B.H.P. DIESEL ENGINE.

MIRRLEES, BICKERTON & DAY, LTD., STOCKPORT.

Fig. 6.

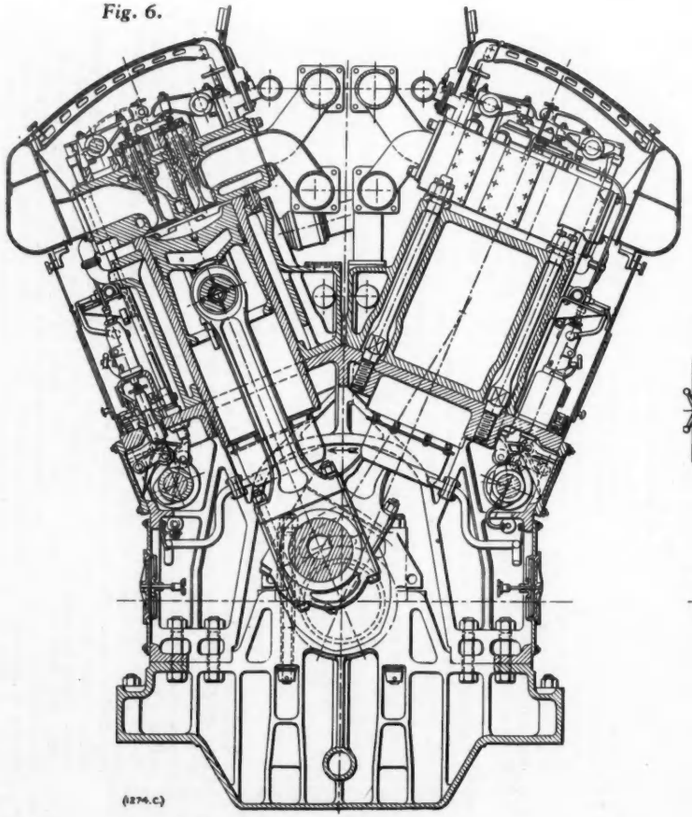
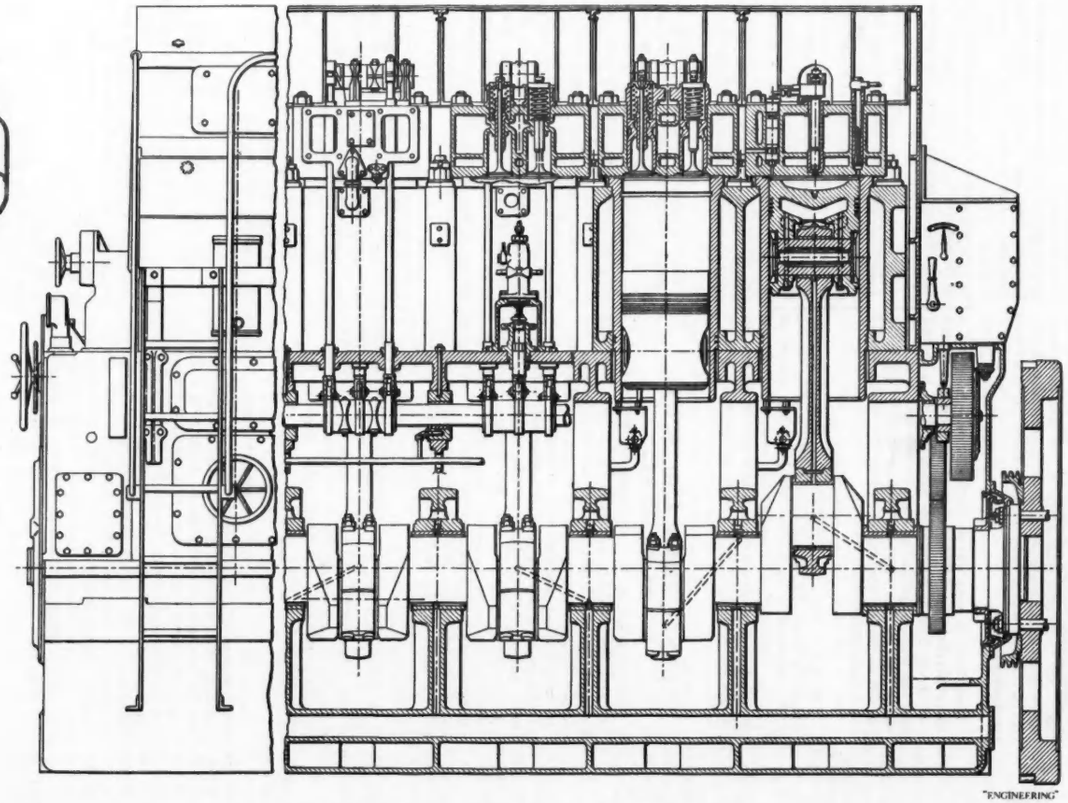


Fig. 7.



"ENGINEERING"

the larger engines, main assembly is carried out on a roller-track conveyor. Extensive use is made of pneumatic tools, jigs, fixtures, cranes and hoists.

The power house is equipped with two Mirrlees Diesel engines, each rated at 750 brake horse-power and driving a generator which develops 900 kW. This electrical output provides a large proportion of the works requirements. The boiler house has two Lancashire boilers which provide space-heating for about 6,000,000 cub. ft. In the past 12 months, a large area of the recently completed extensions has been equipped with radiant-heat panels; this and other measures have effected an appreciable saving in fuel. The test shop and the associated pump house (which is equipped with Heenan and Froude coolers and eight centrifugal pumps) are capable of dealing with 13,000 brake horse-power on test. The plant has been installed below ground level to ensure flooded suction and thus obviate priming difficulties.

The "J" and "K" Engines.

The engines are supplied naturally-aspirated, pressure-charged and high-pressure charged with air intercoolers. Being designed to run at high speeds, while keeping the piston speed reasonable, they are compact in construction. The fact that some of the refinements in design may not be regarded as essential for some applications is outweighed by the low cost of production which is achieved as a result of standardisation. The use of four-valve cylinder heads has permitted the maximum volumetric efficiency to be obtained, a high degree of scavenging and consequently greater output per unit swept volume. Before these engines were finally adopted and put into production, extensive research and experimental work was carried out to ensure that they would meet the severe demands of continuous running at high outputs and that they would have a large margin of power over their normal standard ratings. During experimental work on the JSS 6 engine, a brake mean effective pressure of 220 lb. per square inch was reached when running at 900 r.p.m., and the JVSS 16 engine ran continuously for 1,500 hours at 140 lb. per sq. in. brake m.e.p. Following this it was subjected to a final test at 190 lb. per square inch. The KSS experimental engine was run for 4,000 hours at 140 lb. per square inch b.m.e.p., and performed very satisfactorily even when tested to over 200 lb. per square inch when running at 428 r.p.m.

The following particulars apply to all Mirrlees engines: totally-enclosed, with forced-feed lubrication; turbo-charging on the Buchi principle; the engines supplied as uni-directional or reversible units; automatic starting arrangements as required; compressed-air starting on all cylinders; adequate safety mechanisms, including explosion doors, overspeed and lubricating-oil trips; cylinder relief valves fitted; centralised control station and grouping of instruments, as shown in Fig. 1; various warning systems, as well as electric starting on the J engines, are optional. The J, K and KV engines are of cast-iron construction; the JV engines are of fabricated steel to meet the requirements for mobile units. The V-engines are of particularly robust construction; the short stroke enables a very stiff crankshaft to be used and all the bearings, connecting rods, the main structure and all stressed components are of ample dimensions.

NOTES FROM THE INDUSTRIAL CENTRES.

SCOTLAND.

GLASGOW-GOUROCK RAILWAY BRIDGE.—A proposal to heighten the bridge carrying the Glasgow-Gourock railway over the main road, west of Langbank, is under consideration. The scheme has been prepared by the Ministry of Transport in consultation with the Railway Executive and is designed to increase the headroom at the centre from 13 ft. 8 in. to 15 ft. 6 in. The work is estimated to cost 70,000*l.*

EXPORTS OF SCOTTISH COAL.—Export coal cargoes from Scottish ports during 1952 totalled 924,268 tons, which compared with 807,641 tons in the preceding year. Bunkers (including foreign, Admiralty, and trawler) were slightly lower over the period, at 532,232 tons against 595,258 tons, giving aggregate shipments of 1,456,500 tons, compared with 1,402,899 tons in 1951. Denmark received the largest share of exports, 307,617 tons, followed by Sweden with 135,115 tons, and Eire with 107,647 tons.

FORGING VERSUS CASTING.—Mr. C. A. Parlanti, of the Carron Company, addressing the Institution of Engineers and Shipbuilders in Scotland in Glasgow on January 27, said that, while mechanical properties and uniformity of structure made forging increasingly important, developments in that direction took time, and a system of casting which would give qualities approaching those of forgings was a necessity. Forging capacity was inadequate to cope with large demands at short notice. Anodised-aluminium moulds achieved a more even cooling throughout a casting, giving high physical qualities and freedom from stress; and the castings did not depend for their quality on the availability of skilled labour.

POSSIBLE NEW STEELWORKS IN LANARKSHIRE.—Boring operations by a London firm at the old village of the Craig, between Craigneuk and Carfin, are reported to presage the possible construction of a new integrated steelworks in Lanarkshire. According to unconfirmed reports, these would include a blast furnace, coke-oven batteries, melting furnaces, and rolling mills. It was further stated that the blast furnace might replace one which, it was announced last year, would be erected at Clyde Iron Works, Tollcross, Glasgow, where three are already operating. This was to have a 25-ft. 6-in. hearth diameter and to produce 365,000 tons of pig iron a year.

THE LATE MR. D. M. FERGUSON.—Mr. Daniel M. Ferguson, of Gourock, a well-known member of the Clyde shipping trade over a long period of years, died on January 29 at the age of 73. Mr. Ferguson was managing director of D. McDougall & Co. (Shipping), Ltd., shipbrokers, Greenock. He was chairman of the Greenock Shipowners' and Shipbroking Association and a member of Greenock Harbour Trust.

CLEVELAND AND THE NORTHERN COUNTIES.

FLOODED COLLIERIES CLEARED FOR FURTHER WORK.—The National Coal Board are to install pumps in the shaft at the flooded Eldon Colliery, in south-west Durham, which has been closed for about 20 years. Following the installation of pumping plant at West Auckland, the water in flooded pits has been reduced to a low level and the Board are to resume operations at several pits which have been cleared of water. Coal is likely to be worked again at the old Westerton Colliery, between Bishop Auckland and Spennymoor. One hundred miners will be employed in a drift expected to produce 200 tons of coal a day. A new drift, now being driven into the Hutton Seam at Shildon, will produce between 200 and 300 tons daily.

GREATHAM AIRPORT.—A conference of members of Middlesbrough Town Council and business men is to be held at Middlesbrough Municipal Buildings early in March to discuss the future of the proposed Tees-side airport at Greatham, West Hartlepool. Many of them would like to see Middlesbrough selected as the future airport of the North-East Coast.

EXHIBITION OF GOODS MADE ON TYNESIDE.—Writing in the current issue of the *Journal* of the Newcastle and Gateshead Chamber of Commerce, Mr. J. W. Adamson, vice-president of the Chamber, suggests the establishment of a permanent exhibition of goods manufactured on Tyneside. He adds that the new light industries established in the area have been difficult to bring together and no opportunity should be lost which would help to keep them vigorous and prosperous.

PROPOSED POWER STATION AT BLYTH.—A survey is being carried out of the site of a proposed power station at Blyth, Northumberland, and it is hoped that the work of preparing the site will be started this year. The station would be similar to that now being erected at Stella, near Newcastle-on-Tyne, and would cost about 15,000,000*l.*

THE LATE MR. D. BROWN.—Mr. Donald Brown, managing director of Donald Brown & Co. (Engineers), Ltd., Blaydon-on-Tyne, has died at his home at Heaton, Newcastle. Before the war, Mr. Brown designed a steel house, but production was held up by the war and, later, by the steel shortage.

LANCASHIRE AND SOUTH YORKSHIRE.

THE LATE MR. V. WALKER AND MR. F. GARDNER.—Leyland Motors, Ltd., Leyland, Lancashire, have lost by death two of their senior officials, namely, Mr. Vernon Walker, director and secretary, and Mr. Francis Gardner, Midland regional sales manager. Mr. Vernon Walker, who was a director for more than 30 years, died suddenly at his home in Woodford, Cheshire, on January 18. He was 67. Mr. Walker, who was a chartered accountant, joined the board of Leyland Motors, Ltd. in 1922 and concentrated on the financial side of the business. In 1942, he took over the position of secretary on the retirement of Mr. Phillips-Conn. Mr. Francis Gardner, who had been sales manager in the Midland area for more than 20 years, died at his home at Birmingham on January 22. Mr. Gardner, who was 58, joined Leyland Motors Ltd. in 1908 as office boy and graduated through the headquarter sales office to become North-Western sales manager in 1926. He was appointed sales manager for the Midland region in 1930.

SALE OF OLD SHEFFIELD CUTLERY FIRM.—One of Sheffield's oldest cutlery-manufacturing firms, established in 1681, has been given indirectly a new lease of life by the formation of a new company registered as George Butler & Co. (Cutlers) Ltd. This will maintain the traditions of George Butler & Co., Ltd., of Eyre-street, sold by auction after going into voluntary liquidation. All the Butler trade marks have been acquired by the new company, which will operate under the managing directorship of Mr. S. E. Leppington, who has been in the cutlery industry for over 50 years and is managing director of Leppington (Cutlers), Ltd., of Sydney-street, Sheffield.

RAILWAY COACH-BUILDING AT YORK.—Because more steel is available, it has been decided to resume a limited amount of coach-building at the British Railways shops at York. Some months ago many tradesmen in the shops were transferred to other jobs or dismissed when coach-building was suspended. Metal machinists are being taken on again, the building of underframe work has been started, and it is probable that construction of coach bodies will be undertaken in the course of the next month or so.

ROLLING MILL FOR RESEARCH WORK.—The final stages are being reached in the erection, at Sheffield, of a 60,000*l.* experimental steel rolling mill by the British Iron and Steel Research Association. The 1,500-h.p. main motors are being erected and experimental runs will be made shortly. The mill is the main feature of the research centre, which, since 1950, has expanded to occupy a 2¼-acre site at Hoyle-street, Sheffield. The estimated cost of the first stage of the equipment of the centre is 250,000*l.*

THE MIDLANDS.

SHALLOW COAL AND CLAY WORKINGS.—A meeting with the National Coal Board is being sought by the Urban District Council of Sedgley, Staffordshire, to discuss mining operations on the west side of the local authority's area, where the last of the small pits, once typical of the Black Country, are to be found. Both coal and clay are worked by shaft and drift mines from shallow seams. The mines are operated by private firms, working under licence from the National Coal Board. Since the minerals are only at shallow depths, surface subsidence is considerable in parts of the area. The Council have found that a site scheduled for light industry is unsuitable for immediate use, and they are anxious to obtain full information on the question of both present and future workings.

MERGER OF GLASS-MAKING COMPANIES.—It has been disclosed by Chance Brothers, Ltd., Smethwick, Birmingham, that for the past twelve months, their business has been merged with that of Pilkington Brothers, Ltd., St. Helen's, Lancashire. Chance Brothers, Ltd. were founded at Smethwick in 1824, and, in addition to operating a large glass works, have, on the same site, an engineering works where lighthouse equipment is constructed. This is the only works of its type in this country.

RADIO-CHEMISTRY AT WOLVERHAMPTON TECHNICAL COLLEGE.—The principal of the Wolverhampton and Staffordshire Technical College, Mr. C. L. Old, announced at the annual prize distribution, on January 28, that a radio-chemistry section was to be set up at the college. The new section, which will be one of the first to be established at a technical college in this country, will be set up in conjunction with the atomic energy research station at Harwell and the radio-chemistry school of Cambridge University.

BIRMINGHAM UNIVERSITY.—Professor H. F. Humphreys, Vice-Chancellor of Birmingham University, in his annual report, has asked industry and local authorities in the Midlands to increase the financial support which they already give to the university. Professor Humphreys states that the present Government grants will barely maintain the current research programme, and that, unless the university's income is increased, scientific research in the future will suffer. Technical advances are constantly rendering research equipment out of date, and replacements are becoming more expensive. An estimated figure of 80,000*l.* is given as the additional sum required to enable the university to realise its full potential.

INDUSTRIAL PRODUCTIVITY.—Mr. A. B. Waring, joint managing director of Joseph Lucas, Ltd., Birmingham, and President of the Birmingham Chamber of Commerce, suggested, at a meeting of the Chamber on January 26, the formation of an "industrial league," as a means of raising productivity. Mr. Waring said that industrial concerns could be rated as League 1, 2 or 3, according to their efficiency. This, he said, would engender competition between firms to reach the highest grade, and would be beneficial to all concerned.

SOUTH-WEST ENGLAND AND SOUTH WALES.

TRAINING THE RIVER TAFF.—Preliminary investigations into a scheme for the prevention of erosion and silting of the entrance channel to Cardiff Docks will, it is estimated, cost between 8,000*l.* and 10,000*l.* The Cardiff Port Development Association have been successful in getting the Cardiff Corporation Development Committee to recommend to the Council that a contribution of 2,000*l.* be made, provided that the Government and the Docks and Inland Waterways Executive make similar grants. The scheme proposes to confine the lower reaches of the River Taff within training walls, at an estimated cost of 1,000,000*l.*

COAL FROM RIVER BEDS.—Mr. A. H. Williams, chief pollution officer of the Glamorgan Rivers Board, told a meeting of the Board held at Cardiff on January 29, that, during 1952, the National Coal Board had recovered 165,000 tons of small coal from the River Taff, which was sold for 1*l.* a ton. Large quantities of small coal were also being recovered from other rivers in the county; some yielded more than 200,000 tons a year. A private contractor has been recovering about 50,000 tons of coal a year from the River Rhymney, and was selling it for 29*s.* a ton.

WELSH COAL TRADE.—The South Wales coalfield "lost" 220,430 tons of coal during 1952 as the direct consequence of trade disputes and their resultant small stoppages, "go-slow" working and bans on Saturday shifts, the Ministry of Fuel and Power has reported to a meeting of the Welsh Board for Industry. For the first time since 1947, the rising trend of consumption by industry, in Wales itself, was reversed. The average weekly consumption during 1952 was 61,960 tons, compared with 66,830 tons in 1951. The decrease was most marked in the iron and steel and textile industries. The quantity of electricity produced for public supply in South Wales in 1952 was 3,130·5 million units, compared with 3,174·3 million units in 1951.

DEVELOPMENTS IN THE WELSH STEEL INDUSTRY.—Speaking at Swansea, Lord Lloyd, Under-Secretary for Welsh Affairs, referring to the plans for the erection of a new cold-reduction steel plant at Velindre, near Swansea, said that, when this was completed, West Wales would be the centre of the most modern steel and tin-plate industry in the whole world.

NOTICES OF MEETINGS.

It is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF THE RUBBER INDUSTRY.—*Midland Section:* Monday, February 9, 5 p.m., James Watt Memorial Institute, Birmingham. (i) "Synthetic Rubbers," by Mr. F. A. Jones; and (ii) "Work Study," by Mr. R. G. Porter. *Preston Section:* Monday, February 9, 7.15 p.m., Bull and Royal Hotel, Church-street, Preston. "Adhesives," by Mr. W. H. Swire. *Institution:* Thursday, February 12, 5.30 p.m., 26, Portland-place, W.1. Various short papers.

INSTITUTION OF ELECTRICAL ENGINEERS.—Monday, February 9, 5.30 p.m., Victoria-embankment, W.C.2. Discussion on "Is Technical Advertising Necessary or Desirable?" opened by Mr. W. Bamford. *Western Centre:* Monday, February 9, 6 p.m., Technical College, Bath. "Rectifier-Motor Variable-Speed Drives," by Mr. P. Bingley. *North-Eastern Centre:* Monday, February 9, 6.15 p.m., Neville Hall, Newcastle-upon-Tyne. "Electricity in a Modern Iron and Steel Works," by Mr. W. F. Cartwright. *Radio Section:* Wednesday, February 11, 5.30 p.m., Victoria-embankment, W.C.2. "Method of Designing Transistor Trigger Circuits," by Professor F. C. Williams, F.R.S., and Mr. G. B. Chaplin. *Southern Centre:* Wednesday, February 11, 6.30 p.m., Offices of the South Eastern Electricity Board, Hove. "Earthing," by Mr. P. W. Cave.

ENGINEERS' GUILD.—*West Midlands Branch:* Monday, February 9, 6.30 p.m., Imperial Hotel, Birmingham. Film Evening.

INSTITUTE OF FUEL.—*North-Eastern Section:* Monday, February 9, 6.30 p.m., King's College, Newcastle-upon-Tyne. "Methane Drainage," by Mr. R. L. Cauley and Dr. J. H. Jones. *North-Western Section:* Wednesday, February 11, 2 p.m., Engineers' Club, Manchester. Various short papers.

ILLUMINATING ENGINEERING SOCIETY.—*Sheffield Centre:* Monday, February 9, 6.30 p.m., University, Western Bank, Sheffield, 10. "Specification and Testing of Fluorescent Lamps," by Mr. W. R. Bloxsidge. *London:* Tuesday, February 10, 6 p.m., 2, Savoy-hill, W.C.2. "Colour in Schools," by Mr. David Medd.

INSTITUTE OF METALS.—*Scottish Section:* Monday, February 9, 6.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. "Production of Non-Ferrous Castings," by Mr. R. F. Hudson. *South-Wales Section:* Tuesday, February 10, 6.30 p.m., University College, Singleton Park, Swansea. "Dislocations of Crystals," by Dr. B. A. Bilby.

INSTITUTION OF PRODUCTION ENGINEERS.—*Sheffield Section:* Monday, February 9, 6.30 p.m., Royal Victoria Station Hotel, Sheffield. "Modern Cold-Rolling Mills," by Mr. G. W. Ashton. *Yorkshire Section:* Monday, February 9, 7 p.m., Hotel Metropole, Leeds. "Production of Diesel-Engine Components," by Mr. A. E. Groocock. *Halifax Section:* Tuesday, February 10, 7.15 p.m., White Swan Hotel, Halifax. "Manufacture of Ball and Roller Bearings," by Mr. R. K. Allan. *Dundee Section:* Tuesday, February 10, 7.30 p.m., Queen's Hotel, Dundee. "Watch and Clock Production," by Mr. R. Lenoir. *Preston Section:* Wednesday, February 11, 7.15 p.m., Crown Hotel, Market-place, Blackburn. "Standardisation in Engineering," by Mr. E. G. Brisch. *London Section:* Thursday, February 12, 7 p.m., Royal Empire Society, Northumberland-avenue, W.C.2. "Factory Services," by Mr. R. E. Leakey. *Rochester Section:* Thursday, February 12, 7.30 p.m., Sun Hotel, Chatham. "Practical Gear Production," by Mr. L. Westley-Smith.

INSTITUTION OF WORKS MANAGERS.—*Manchester Branch:* Monday, February 9, 6.45 p.m., Grand Hotel, Manchester. "Standardisation in Industry," by Mr. A. F. B. Nall. *Merseyside Branch:* Tuesday, February 10, 6.30 p.m., Adelphi Hotel, Liverpool. "Factory Discipline," by Mr. J. Ayres.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS.—*Central London Branch:* Monday, February 9, 6.45 p.m., St. Ermin's Hotel, Caxton-street, S.W.1. "Corrosion and Cathode Protection," by Mr. G. G. Portch. *Bradford Branch:* Wednesday, February 11, 7.30 p.m., Midland Hotel, Bradford. "Factory Maintenance," by Mr. J. W. White. *Liverpool Branch:* Friday, February 13, 7.30 p.m., 9, Whitechapel, Liverpool. Film on "Electronics in Industry."

SHEFFIELD METALLURGICAL ASSOCIATION.—Monday, February 9, 7 p.m., The University, St. George's-square, Sheffield. "Anglo-American Productivity Report on Iron and Steel," presented by Sir Charles Goodeve.

JUNIOR INSTITUTION OF ENGINEERS.—*North-Western Section:* Monday, February 9, 7 p.m., 16, St. Mary's Parsonage, Manchester. Discussion on "Coal Utilisation." *Sheffield Section:* Monday, February 9, 7.30 p.m., Livesey Clegg House, Union-street, Sheffield. "Mechanisms in Paper-Wrapping Machines," by Mr. J. A. Cuckson.

INSTITUTION OF ENGINEERING INSPECTION.—*Wolverhampton Branch:* Monday, February 9, 7.30 p.m., Compton Grange, Compton-road, Wolverhampton. "Arc Welding," by Mr. G. G. Musted. *Leeds Branch:* Wednesday, February 11, 7.30 p.m., Church Institute, Albion-place, Leeds. Film Evening.

INCORPORATED PLANT ENGINEERS.—*Dundee Branch:* Monday, February 9, 7.30 p.m., Mathers Hotel, Dundee. Film on "Manufacture of Plate Glass." *East Lancashire Branch:* Tuesday, February 10, 7.15 p.m., Engineers' Club, Manchester. "Instrumentation and Automatic Control for Medium and Small Boilers," by Mr. A. Klepp. *East Midlands Branch:* Wednesday, February 11, 7 p.m., Welbeck Hotel, Nottingham. "An Approach to Maintenance," by Mr. H. G. Hilton.

ROYAL INSTITUTION.—Tuesday, February 10, 5.15 p.m., 21, Albemarle-street, W.1. "Experimenting at High Pressures—III," by Prof. D. M. Newitt.

INSTITUTION OF CIVIL ENGINEERS.—*Structural and Building Engineering Division:* Tuesday, February 10, 5.30 p.m., Great George-street, S.W.1. "Corrugated-Concrete Shell Roofs," by Mr. J. H. de W. Waller and Mr. A. C. Aston. *Midlands Association:* Thursday, February 12, 6 p.m., James Watt Memorial Institute, Birmingham. Vernon Harcourt Lecture on "Practical Methods of Flood Protection," by Mr. W. E. Doran. Also at the *Yorkshire Association:* Friday, February 13, 6.15 p.m., Guildhall, Hull.

INSTITUTE OF MARINE ENGINEERS.—Tuesday, February 10, 5.30 p.m., 85, Minories, E.C.3. "Atomic Propulsion, with Special Reference to Marine Propulsion," by Sir John Cockcroft, F.R.S.

INSTITUTION OF CHEMICAL ENGINEERS.—Tuesday, February 10, 5.30 p.m., Geological Society, Burlington House, Piccadilly, W.1. "Heat Transfer from Luminous Gas Flames in Vertical Tubes," by Mr. S. R. Tailby and Mr. Muhammed Aly Saleh.

INSTITUTION OF MECHANICAL ENGINEERS.—*South Wales Branch:* Tuesday, February 10, 6 p.m., Mackworth Hotel, Swansea. Discussion on "The Anglo-American Productivity Report on Plant Maintenance," opened by Mr. D. G. Hitt. *Western Branch:* Thursday, February 12, 7 p.m., Grand Hotel, Bristol. Thomas Hawksley Lecture on "The Mechanism of Work-Hardening in Metals," by Professor N. F. Mott, F.R.S. *Institution:* Friday, February 13, 10.30 a.m., 2.30 p.m. and 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. Conference on "Hydraulic Servo-Mechanisms." For programme, see page 69. AUTOMOBILE DIVISION.—*Derby Centre:* Monday, February 9, 7.15 p.m., Midland Hotel, Derby. "Diesel Electric Locomotives," by Mr. E. R. Montague. *Luton Centre:* Monday, February 9, 7.15 p.m., Town Hall, Luton. "Research and the Engineering Process, Especially in the Automobile Industry," by Dr. H. E. Merritt. *London:* Tuesday, February 10, 5.30 p.m., Storey's-gate, St. James's Park, S.W.1. Joint Meeting with INSTITUTION OF ELECTRICAL ENGINEERS. "Ignition Interference with Television Reception," by Mr. A. H. Ball and Mr. W. Nethercot.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, February 10, 6.30 p.m., 39, Elmbank-crescent, Glasgow, C.2. "Cranes," by Mr. J. Patrick.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—*South Western Branch:* Tuesday, February 10, 6.30 p.m., G.E.C. Building, Cathays Park, Cardiff. "Automatic Controls for Heating Equipment," by Mr. K. Ernest.

NEWCOMEN SOCIETY.—Wednesday, February 11, 5.30 p.m., Science Museum, S.W.7. "Early Polishing of Diamonds and Gemstones," by Mr. P. Grodzinski.

INSTITUTE OF PETROLEUM.—Wednesday, February 11, 5.30 p.m., 26, Portland-place, W.1. "Oil Operations in Western Canada," by Mr. C. S. Lee and Dr. R. O. Young.

BRITISH INSTITUTION OF RADIO ENGINEERS.—*London Section:* Wednesday, February 11, 6.30 p.m., London School of Hygiene and Tropical Medicine, Gower-street, W.C.1. "Modern Trends in Communications Materials," by Mr. L. A. Thomas.

INSTITUTION OF STRUCTURAL ENGINEERS.—*Wales and Monmouthshire Branch:* Wednesday, February 11, 6.30 p.m., Mackworth Hotel, Swansea. "Fourth Congress, International Association of Bridge and Structural Engineering," by Mr. D. Manolopoulos. *Institution:* Thursday, February 12, 6 p.m., 11, Upper Belgrave-street, S.W.1. "Strength of Brickwork," by Dr. F. G. Thomas.

MANCHESTER ASSOCIATION OF ENGINEERS.—Wednesday, February 11, 7.30 p.m., College of Technology, Manchester. "Progress in Engineering Training," by Sir Arthur P. M. Fleming.

ROYAL SOCIETY.—Thursday, February 12, 4.30 p.m., Burlington House, Piccadilly, W.1. "Research Work of Geological Survey," by Professor W. J. Pugh, F.R.S.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, February 13, 6.15 p.m., Neville Hall, Newcastle-upon-Tyne. "Non-Destructive Testing in Industry," by Mr. J. D. Hislop.

PERSONAL.

SIR COLIN ANDERSON has been re-elected chairman of the International Chamber of Shipping, 3-6, Burycourt, St. Mary Axe, London, E.C.3, for a further period of two years. MR. L. HOEGH, C.B.E., of Norway, has been re-elected vice-chairman. MR. F. FABRE, of France, has been elected to succeed, as joint vice-chairman, MR. D. A. DELPRAT, of Holland, who has retired under the rules.

MAJOR-GENERAL C. BULLARD, C.B., C.B.E., Inspector of the R.E.M.E., is retiring in April next. Appointments arising from General Bullard's retirement include Brigadier F. M. Hext, O.B.E., at present Director of Mechanical Engineering, Northern Army Group, to Inspector of the R.E.M.E. (in the rank of Major-General); Brigadier G. E. Butler, now Commandant, R.E.M.E. Training Centre, to D.M.E., Northern Army Group; and Brigadier L. H. Howard-Jones, C.B.E., Deputy Director of Mechanical Engineering, Southern Command, to Commandant, Training Centre.

DR. J. H. CHESTERS, assistant director of research, United Steel Companies Ltd., Sheffield, has been given the Robert W. Hunt award of the American Institute of Mining and Metallurgical Engineers, for 1953, for his paper, "Flow Patterns in Open-Hearth Furnaces."

MR. G. B. HOWDEN, M.I.C.E., is to be chairman of the Ulster Transport Authority, as from April 1, on the completion of the term of office of MR. J. SYDNEY ROGERS.

MR. WILLIAM MASTERTON, C.A., and DR. S. G. HOOKER, O.B.E., D.I.C., F.R.Ae.S., have been elected directors of the Bristol Aeroplane Co. Ltd., Bristol.

MR. N. A. F. ROWNTREE is relinquishing his post as engineer and manager to the Mid and South East Cheshire Water Board on March 31 to become a partner in the firm of Rofe and Raffety, consulting engineers, Westminster. His successor as engineer and manager is MR. D. G. DAVIES, previously engineer and manager of Harrogate Water Department.

MR. GEORGE WILSON, deputy chairman and managing director of Raleigh Industries Ltd., Nottingham, has been appointed a Governor of Loughborough College.

MR. R. M. GARLAND, chief engineer to Veeder-Root Ltd., Dundee, has been elected a director. He will continue to act as deputy to the managing director.

MR. JOSEPH BROWN, M.I.Mech.E., F.I.R.I., has been appointed chairman and managing director of David Bridge & Co. Ltd., Castleton, Rochdale.

MR. HERBERT SMITH has relinquished the office of managing director of British Ropes Ltd., Doncaster, but will continue as chairman. MR. HARRY SMITH and MR. ALEXANDER SMITH PEARCE are appointed joint managing directors, and MR. J. R. DAWSON, a director.

MR. H. W. HARDERN, Assoc.M.C.T., M.I.E.E., has been made assistant chief engineer, transformer department, Metropolitan-Vickers Electrical Co. Ltd., Manchester, 17. MR. E. L. N. TOWLE, B.Sc.(Eng.), M.I.E.E., M.I.Mech.E., M.I.Mar.E., is to be assistant chief engineer (industrial), and MR. F. B. HOLT, A.M.I.E.E., consultant (industrial), both in the electrical general engineering department.

MR. R. C. JENNISON, of Manchester University, and DR. F. K. DUXBURY, of King's College, Durham University, have been awarded Mackinnon Research Studentships by the Council of the Royal Society.

MR. E. L. CADWALLADER has relinquished his executive appointment, but retains his seat on the board of C.A.V. Ltd., Acton, London, W.3. MR. H. G. MASON has been appointed joint general manager.

MR. R. D. V. ROBERTS, B.Com., has been appointed deputy director of welfare, British Electricity Authority, but will, at the same time, continue his present duties as secretary, National Joint Advisory Council.

MR. R. W. OGDEN, Birmingham office manager, Dewrance & Co. Ltd., has resigned and left the engineering industry. He has been succeeded by MR. A. BROWN, formerly representative for the Yorkshire area, now taken over by MR. R. E. F. ELLWOOD, located in Leeds.

MR. R. J. MCMILLAN has retired after 37 years of service as an industrial salesman with the Vacuum Oil Co. Ltd., Caxton House, London, S.W.1.

MR. P. WEBB has been appointed manager of the London office of Laurence, Scott and Electromotors Ltd., Manfield House, Southampton-street, Strand, W.C.2.

MR. C. G. E. JOSLIN, A.M.I.E.E., has been appointed assistant manager in Australia for W. T. Henley's Telegraph Works Co. Ltd.

MR. C. W. J. CLARIDGE, A.M.I.Mech.E., has been appointed sales engineer of Commer Cars Ltd. and Karrier Motors Ltd., Luton, in place of the late MR. A. H. GLASSPOLE.

A new company, METALOCK (SOUTH AFRICA) LTD., is in process of formation; the general manager will be COMMANDER P. KEEBLE.

PRODUCTION OF DIESEL ENGINES.

MIRRLEES, BICKERTON & DAY, LTD., STOCKPORT.

(*For Description, see Page* **171.**)

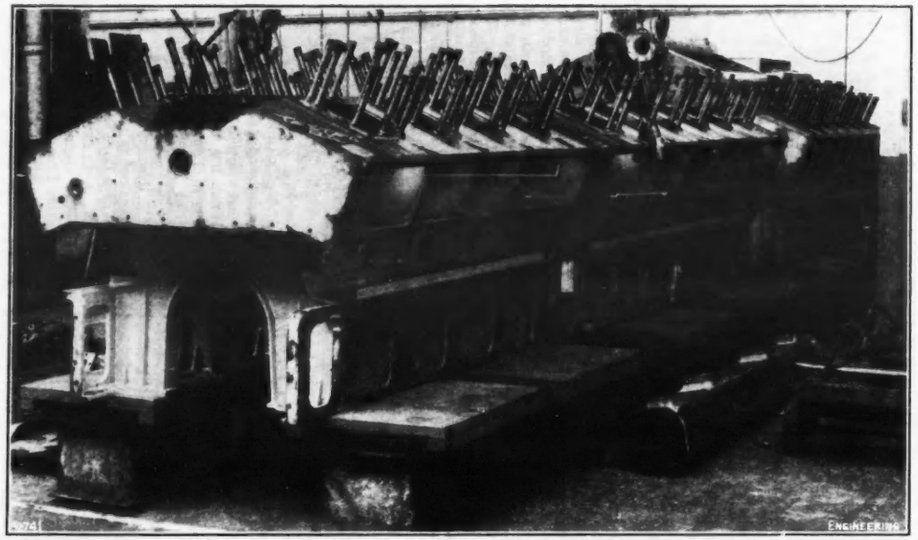


FIG. 8. PARTLY-ASSEMBLED COLUMNS FOR JV-TYPE ENGINES.

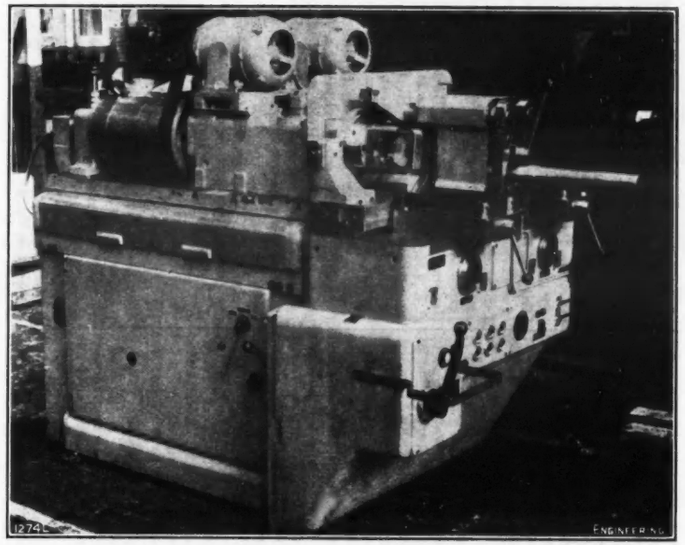


FIG. 9. PISTON LATHE.

FIG. 10. BEDPLATE-BORING MACHINE.

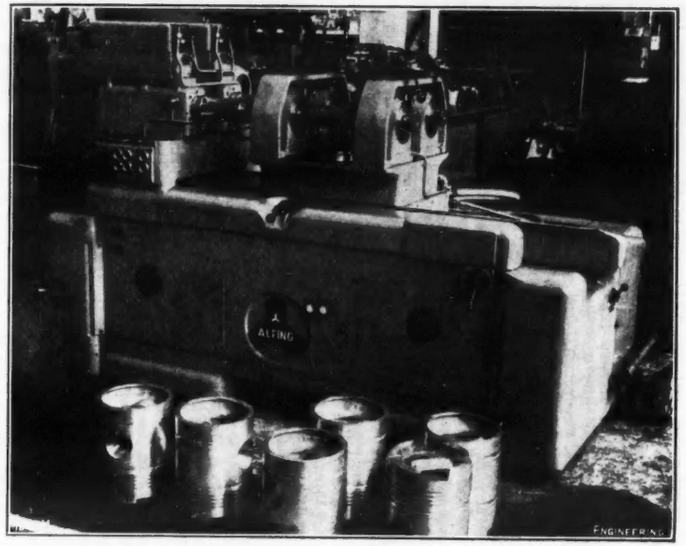


FIG. 11. PISTON-BORING MACHINE.

ENGINEERING

35, & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

Registered at the General Post Office as a Newspaper.

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Terms for displayed advertisements can be obtained on application to the Manager. The pages are 12 in. deep and 9 in. wide, divisible into four columns 2¼ in. wide. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

The charge for advertisements classified under the headings of "Appointments Open," "Situations Wanted," "Tenders," etc., is 10*s.* for the first four lines or under, and 2*s.* 6*d.* per line up to one inch. The line averages six words and when an advertisement measures an inch or more, the charge is 30*s.* per inch. If use is made of a box number the extra charge is 1*s.* per insertion, with the exception of advertisements appearing under "Situations Wanted." Series discounts for all classified advertisements can be obtained at the following rates:—5 per cent. for six; 12½ per cent. for thirteen; 25 per cent. for twenty-six; and 33⅓ per cent. for fifty-two insertions.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be received not later than first post Wednesday.

"Copy" instructions and alterations to standing advertisements for display announcements must be received 14 days previous to the date of publication, otherwise it may be impossible to submit proofs for approval.

The Proprietors will not hold themselves responsible for advertisers' blocks! eft in their possession for more than two years.

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PLATE.

Plate III.—HEAVY MACHINE SHOP AT A DIESEL ENGINE WORKS.

ENGINEERING

FRIDAY, FEBRUARY 6, 1953.

VOL. 175. No. 4541.

THE STORM AND AFTER.

BY common consent, the hurricane which swept across the British Isles nearly 250 years ago—towards the end of November, 1703—is still referred to as "The Great Storm," and its claim to that distinction has not been seriously challenged since; but to describe that of last week-end as "the storm," without further qualification, will not be misunderstood by any readers of this week's issue of ENGINEERING who lived through those two disastrous days, whether they read this brief summary of its effects in the near or distant future. As we write, the death roll in the floods along the east and south-east coasts of England is stated to be 265, though this figure is certain to be exceeded; and to the total must be added the 128 who were lost when the motorship Princess Victoria foundered on the short passage from Stranraer to Larne, the 15 who went down with the Fleetwood trawler Michael Griffith, the 39 in the York trooping aircraft which disappeared over the Atlantic, and a number of isolated casualties at different places round the British coastline. These totals, however, serious as they are, are far outweighed by the calamitous breaches of the Dutch dykes, which have caused some 1,270 known deaths and have left a sixth of Holland's hard-won land once again under water.

The cause of this widespread devastation was a depression over the Atlantic, to the north-west of Scotland, which moved eastward on the night of Friday last, January 30, causing north-westerly gales of steadily increasing intensity on the west coast of Scotland and in the north of the Irish Sea. As these gales progressed down the North Sea, blowing with gusts of over 100 miles an hour in many places in the north of Scotland, the effect was to add to the height of the high tides that had been expected in the normal course, piling up the water against the English and Dutch coasts, where the width of open water between them is so much less than it is between Scotland and Norway, until the sea poured over the defences, causing in all some hundreds of breaches between the Humber and the coast of Kent. The extraordinary height of the water level is evidenced by the fact that water flowed over the top of the dock gates at Sheerness dockyard, filling the hull of the submarine Sirdar, which was in dry dock with some shell plates removed, and washing out the bilge shores under the Sirdar and the frigate Berkeley Castle, causing both ships to fall over on their sides. The damage to these ships alone has been estimated at 1,000,000*l.*

The loss of the Princess Victoria is to be the subject of a Ministry of Transport "formal investigation," and, though none of the officers appears to have survived, several members of the crew, including a petty officer, were rescued and, it may be supposed, will be able to provide a fairly connected account of the events leading to the sinking of the ship. It has been stated that the vessel became out of control after a heavy sea had struck the stern and burst in the doors at the after end of the car deck. This deck, extending for more than half of the length of the ship, became flooded, and water poured into the engine room. As the car-deck doors folded inboard, it can be seen that they would act as a non-return valve, preventing the water from flowing out over the stern as freely as it entered; and, most unfortunately, the Diesel-driven emergency generator was on the car deck. As a depth of water of 1 ft. over the area of the car deck would represent a weight of about 2,000 tons, the fact that the vessel eventually capsized is not surprising. Her normal displacement was only a little over 2,400 tons. The result of the formal investigation will be awaited with considerable interest on technical grounds, and it may well lead to the drafting of some new regulations affecting the design of car ferries.

Whether the failure of so many sea walls and banks will lead to any fundamental change in this branch of civil engineering design and practice is problematical. The principal defect of most of the banks and dykes which failed appears to have been merely that they were not high enough; but as some of them had functioned satisfactorily for much longer than living memory, their designers and constructors can hardly be accused of any professional shortcoming. It has been announced that two parties of experts from the Hydraulics Research Station at Wallingford are surveying the damage on the east coast, to ascertain if any useful lessons can be derived from it. An early publication of their reports, without waiting for the next annual report of the Director, Sir Claude Inglis, would certainly be welcomed by both consultants and engineering contractors; they will have an immense amount of repairs and reconstruction to undertake—probably several years of work—and will have to make a start on it without delay.

Meanwhile, there is every indication that the measures taken to meet the emergency have operated with commendable smoothness and efficiency. The immediate urgency, of course, was to save life, and provide the rescued with food, clothing and shelter; the next, to restore the public services, especially water supply and sanitation, and to take steps to guard against any outbreak of disease that

might result from damage to sewers, dispersal of their contents, and contamination by the decomposition of bodies, more particularly those of cattle, which are not easily removed and disposed of when roads are under water, even if it is certain that they have all been located. Concurrently, moreover, the breached defences must be restored to something approaching watertightness before the openings are further widened by scour; and this work assumes even greater urgency when, as in the present case, there are warnings that renewed gales are possible, and high tides are a certainty.

In this emergency, the assistance rendered by the Royal Navy, the Army and the Royal Air Force has been of immense value. To mention only a few instances: at Sheerness, where the water supply is too seriously contaminated to be safe, the Navy has been supplying water from Chatham by tank barges, for distribution by tank vehicles. The Royal Engineers belonging to Eastern Command, whose headquarters are at Hounslow, have supplied draglines, bulldozers and other earth-moving equipment which is now at work at Foulness, Southwold, Tilbury, Dartford, Rainham and elsewhere, and are ready to provide more when the floods have subsided sufficiently for it to be used. Some ten millions of sandbags have been distributed, and many thousands of Service men are engaged in closing breaches with them. In some of the areas affected, the War Department are the owners of the flooded land—for example, at Foulness, which is wholly W.D. property, and in the Isle of Grain. Seven hundred men of the Royal Artillery, from Woolwich, are at work along the southern bank of the Thames, between Erith and Greenhithe and near Dartford. As the civil authorities surmount their immediate difficulties, the Service personnel will be concentrated more on the Government property, but at present both administrations are working together, wherever the need is greatest.

The Minister of Agriculture, Sir Thomas Dugdale, stated in the House of Commons on February 2 that 250,000 acres of land had been covered by sea water and that, along the coast of Essex alone, there were 280 breaches in the sea defences. He added, with reason, that the necessary reconstruction of those defences "will present one of the greatest civil engineering problems that we have ever had to face." Obviously, the cost is much more than any local authority or River Board could contemplate bearing unaided, and it may be assumed that the Prime Minister's assurance, that the disaster would be regarded by the Government as a national responsibility, is a precedent which, in due time, will be extended to cover a substantial part, at any rate, of the expenditure necessary to prevent a repetition.

In the midst of these problems, it is safe to say that the plight of the Netherlands will be constantly in the minds of those who are most closely concerned with the task of fortifying England against a renewed attack by the sea. The Dutch had so much to bear during the war and immediately after it, and acquitted themselves so valiantly in organising their country's recovery, that their present catastrophe must inspire more than ordinary sympathy. In the department of the Rijkswaterstaat they have an organisation second to none in its expert knowledge of the engineering tasks that confront the Dutch nation, and prompt aid has come from their immediate neighbours; but the damage is on such a scale, quite apart from the grievous loss of life, that the courage and resourcefulness of the Dutch people must be severely taxed, however liberal the assistance that they receive in men, money and materials. Britain will certainly rejoice with the Netherlands when the last breach has been filled and the Dutch people can repeat the proud inscription that commemorates the closing of the Zuider Zee—"Hier Wer de Dijk Gesloten."

THE UNIVERSITIES AND INDUSTRY.

IT possibly does not frequently occur to the staff members and administrative officers of the universities that their salaries, and the cost of running the organisations with which they are concerned, are paid by industry—"industry" in this connection, including various ancillary activities, such as shipping. This is not to say that the proceedings of the universities may not have influence on the efficiency with which industry is conducted, but, none the less, it is industry that provides the money. Members of university staffs are painfully aware that substantial proportions of their salaries are taken in taxation and added to the general fund from which the State pays for various things, including universities, but this does not make members of university staffs direct creators of wealth. The arrangement is merely part of the system of give and take which has been developed to such an admirable degree of complexity. Part of the sum extracted from each individual in the form of taxation is later returned to him in the form of subsidies of various kinds, very large staffs being employed to do the necessary arithmetic. It all appears a little complicated, but that is the system on which the country is now run.

If, then, industry pays for the universities, it is reasonable for industrialists to ask what return is being made for the money. Lord Hives, chairman of Rolls Royce Limited, read a paper last year which he entitled "What Industry Requires from the Universities." He did not demand to know what industry was getting; he probably knew. The conference at which Lord Hives spoke was held at Nottingham University on September 24, 1952, and was organised by the North Midland Regional Council of the Federation of British Industries in conjunction with the University of Nottingham. Its purpose was to discuss the subject of "Industry and the Universities," A report* of the addresses given, and what would appear to be no more than brief summaries of the discussions to which they led, has now been published by the Federation of British Industries.

This was the sixth regional conference of this type to be organised by the Federation and, as Lord Hives pointed out in his address, the subject of industry and the universities has already been discussed at great length by politicians, industrialists and educationists. This is tacitly recognised in a preface to the report, contributed by Mr. G. H. Spencer, chairman of the F.B.I. North Midland Regional Council and Mr. B. L. Hallward, Vice-Chancellor of the University of Nottingham, but it is contended that the "educational revolution," represented by the fact that the pre-war university population of 50,000 has now increased to 85,000, is of such significance that still further opportunity for discussion, which might range "from informed opinion to sturdy prejudice," was justified. Of necessity, the subject of industry and the universities has usually been discussed in general terms and the most important information in this preface is that a small joint committee is being formed to examine practical proposals and strengthen the ties of mutual understanding and co-operation between the University of Nottingham and local industry.

Anyone who has cared to follow even a small part of the discussions which have ranged round this subject will know that, according to some opinion, what the country requires is a technological university that would turn out graduates fully equipped to be of service in industry, while others are convinced that such an institution would be highly undesirable, as it would produce narrow-minded specialists. Similarly, while some hold that the main service of a university is to furnish a broad training and inculcate a wide outlook, which is likely to be engendered by contacts between undergraduates studying in very different fields, others maintain that, if an engineering undergraduate spends much of his time taking an interest in extraneous matters, he is hardly likely to master the rigid discipline of his subject. Students should be instructed in works management, according to some; but others argue that attention to such a subject at the undergraduate stage is a waste of time.

In the welter of opinion, it is a matter of some satisfaction that, in the engineering field, at least, present arrangements appear to be working satisfactorily and the graduates produced are proving capable of serving industry; the main difficulty is that there are not enough of them. This latter remark applies more particularly to the better men, but the shortage is probably to be attributed to the proportion of good brains which the nation is producing rather than to anything that the universities are or are not doing. Many large engineering firms have worked out a satisfactory method of using the university product, but smaller establishments may not find it possible to imitate their procedure. It is for cases of this kind that the joint committee, mentioned in the preface to the report, may be of service. It is not only in engineering that university graduates may find useful careers, but many industries of other types do not seem to have realised fully that they may draw useful recruits from university sources. A committee representing a university and local firms might do much towards educating them.

The practice of Rolls-Royce, Limited, forms an outstanding example of the way in which large engineering firms are utilising university graduates and Lord Hives gave a clear and valuable account of the procedure employed. The firm have about 350 graduates on their staff; 75 per cent. of these were recruited from universities and technical colleges and 25 per cent. obtained London external degrees while serving their apprenticeships. The staff also includes about 400 men holding Higher National Certificates. Lord Hives considers that these figures are on the low side, but, presumably, they are determined by supply possibilities. The university graduates are selected before the results of the final examination are available. That the judgment of the selection committee is sound is shown by the fact that last year, of 34 men selected, eight obtained first-class honours; 17, second-class honours; and six, pass degrees. In three cases, the results were not known at the time of the conference.

Lord Hives points out that the figures for academically-trained men are very much lower than are quoted for American firms. He does not think it necessary to copy American practice in this respect, but he does think it essential to maintain, and if possible improve, the quality of British graduates. The experience of his firm indicates that there may be a risk of increasing the university output at the expense of quality, either because of the increasing demand for university-trained technologists or because the best brains may be directed elsewhere than into engineering. The first of these reasons seems the more likely, for the Rolls Royce selection committee is far from being the only one eager to obtain the most promising graduates. It is not, however, the quality of the best men about which Lord Hives indicated anxiety; in their case, the trouble is that there are not enough of them. It is in the average man that "we should see an improvement in quality."

* *Report of the Conference on Industry and the Universities held at Nottingham University, 24 September, 1952.* The Federation of British Industries, 21, Tothill-street, London, S.W.1. [Price 4s. 6d.]

One of the papers read at the conference carried the lengthy title, "The Study of Industrial Organisation and Management as an Academic Discipline, and the Contribution which industry itself can make in this Field." (A non-economist is tempted to reduce this rigmarole to about eight words.) The paper was read by Dr. F. A. Wells, Head of the Department of Industrial Administration of Nottingham University. As will be clear from its title, it was a plea for the co-operation of industry in the study of business administration as a university subject. No doubt, this would be of value to students of economics, but, though much has been said and written about the value, and even necessity, of instructing engineering students in problems of management, it is of interest that Sir Edward Herbert, managing director of William Hollins and Company, in a paper entitled "What is the Best Training for the University Student who wants to Find a Career in Industry?" said, "I am most certainly not in favour of the universities introducing 'business administration' as a subject for undergraduate study."

Lord Hives had some remarks to make on this subject. He thought there was need for a good post-graduate school in administrative studies, but did not appear to contemplate such matters forming part of a degree course. His firm, he said, had always been controlled by engineers, and men with the qualities necessary for management were found among the engineers employed. He did not think that arts graduates trained in administrative studies were suitable for top positions in the management of large engineering organisations. Although he did not specifically say so, Dr. J. A. Pope, Professor of Civil and Mechanical Engineering at Nottingham, appeared to agree with this. In the paper which he contributed, entitled "What the Universities can Contribute to the Needs of Industry" he stressed the need for a broad outlook in graduates and pointed out that, during the years spent at college, an undergraduate had an opportunity to develop qualities, quite apart from those associated with technical knowledge, which are of value in industry. This is altogether a different matter from training in industrial procedure. In view of the scale and success of American production methods, it might be supposed that British firms should study and copy United States practice and employ men trained solely in business administration, on the lines so popular in America. Lord Hives does not consider this procedure suitable, at least for his firm; in his view, "the business of administration and engineering control cannot be successfully divorced." Whatever those who lay stress on business administration as a special study may think of this, no one is likely to suggest that the directors of Rolls-Royce, Limited, do not know how to operate a commercial organisation.

NOTES.

THE INSTITUTION OF MECHANICAL ENGINEERS.

AT a meeting of the Institution of Mechanical Engineers held on Friday, January 30, with Mr. I. V. Robinson, chairman of the Steam Group, in the chair, a paper on "Scale Formation in Sea-Water Distilling Plants and its Prevention" was presented by Mr. H. Hillier, O.B.E., M.I.Mech.E., engineering and technical director of Messrs. G. and J. Weir, Limited, Glasgow. In a summary of the paper it was stated that the scales found in sea-water evaporators were formed of calcium sulphate, calcium carbonate, and magnesium hydroxide. Calcium-sulphate scale could be avoided by using a sufficiently dilute brine concentration to maintain the sulphate in solution. Calcium-carbonate and magnesium-hydroxide scales were due to the carbonate alkalinity in the sea water, which was limited and reasonably constant. These scales were due to the break-up of the bicarbonate ions in the sea water as heating and boiling occurred. Up to a well-defined range of operating temperatures, a scale that was predominantly of calcium carbonate was experienced. At higher temperatures, a scale predominantly of magnesium hydroxide was formed; but both types of scale might occur in the region of the change-over zone. It was shown that the break-up of the bicarbonate ions produced carbonate ions, which gave rise to the calcium-carbonate scale, and that, with further heating and boiling, break-up of the carbonate ions occurred with the formation of hydroxyl ions, which combined with magnesium ions to form the magnesium-hydroxide scale. It was shown that some of the alkalinity left the evaporator with the blow-down, as calcium carbonate in solution, or calcium carbonate and/or magnesium hydroxide in suspension. The amount of scale was proportional to the amount of sea water used, and no benefit was obtained by operating at low brine densities. It was shown that the rate of scale formation was greater for low temperatures than for high temperatures and increased with the temperature difference across the heating surface. Tests showed that the use of organic dispersive compounds gave rise to a weaker scale structure, which allowed some of the scale to be shed by cracking. The calcium-carbonate and magnesium-hydroxide scales could be completely prevented if the appropriate quantity of hydrogen ions was supplied by the injection of acids such as hydrochloric or sulphuric acid, or an acid salt such as sodium bisulphate. These scales could also be prevented by injecting ferric chloride, which provided a supply of ferric ions. The ferric ions combined preferentially with the hydroxyl ions formed by the break-up of the bicarbonate and carbonate ions, thus allowing the formation of ferric hydroxide, which was very soluble and was maintained in suspension in the brine without forming scale. Long-period tests on large commercial plants had confirmed the research tests.

THE BRITISH HYDROMECHANICS RESEARCH ASSOCIATION.

The fifth annual report of the British Hydromechanics Research Association, which has been published recently, covers the period from October, 1951, to September, 1952, and is the first covering a full year's activity at the Association's new headquarters and laboratory at Netteswood-road, Harlow, Essex. During the year, both the staff and the number of investigations being undertaken were expanded, and the year ended with "Open Days" at the laboratory on September 24 and 25, and with an annual conference held at Selwyn College, Cambridge, on the three following days. A description of the apparatus on view during the open days and of the investigations being undertaken was given at the time in ENGINEERING (page 477, vol. 174, 1952). Of the fourteen papers read and discussed at the conference, five were contributed by members of the staff of the laboratory and the remainder by members of the Association. The subjects of the papers covered problems related to centrifugal and reciprocating pumps, turbines, hydromechanical measurements, pipe flow and the hydraulic transport of solids. Membership of the Association has grown during the year and now comprises 35 firms engaged on making pumps and allied machinery, 11 user members, 20 consultants and 36 university teachers in the United Kingdom and the Commonwealth; this represents an increase of six ordinary members and seven associate members during the year. The total income for the year amounted to nearly 30,000*l.*, which included a block grant and an additional grant from the Department of Industrial and Scientific Research amounting to 9,400*l.*, and fees of nearly 8,500*l.* earned by the laboratory for undertaking special investigations. The library and information services have been augmented and an abstract bulletin is now published every second month, giving detailed information of the current work of the Association and critical reviews and abstracts from both books and papers, of world-wide origin, on hydromechanics.

FLIGHT TO AUSTRALIA IN ONE DAY.

Subject to confirmation by the Fédération Aéronautique Internationale, two international speed records, between London and Karachi, and London and Darwin, were set up by a Canberra photographic reconnaissance aircraft in the course of a delivery flight from London to the Woomera rocket range, where it is to be used for experimental work. Official timekeepers of the Royal Aero Club timed the aircraft at London airport, Karachi and Darwin. The pilot of the aircraft, Flight Lieutenant L. M. Whittington, and the navigator, Flight Lieutenant J. A. Brown, are both serving at the Ministry of Supply's Aeroplane and Armament Experimental Establishment at Boscombe Down, Wiltshire. The Canberra took off from London Airport at 8.36 a.m. on Tuesday, January 27, and covered the distance of 3,921·2 statute miles, between London and Karachi, in 8 hours 52½ minutes, including a refuelling stop at Fayid, at an average speed of 441·8 m.p.h. The previous record, set up in 1949 by Squadron Leader Neville Duke in a Hawker Sea Fury aircraft, was 256 m.p.h. The Canberra arrived at Darwin airport, Australia, at 6.38 a.m. G.M.T. on Thursday, January 28, with another refuelling stop at Singapore. Thus the distance between London and Darwin, 8,608·5 statute miles, was covered in just over 22 hours, at an average speed of 391·2 m.p.h. The previous speed record for the London-Darwin route was 189·9 m.p.h., set up in 1946 by the Aries, a Royal Air Force Lancaster aircraft. The Canberra aircraft is constructed by the English Electric Company, Limited, Warton, Lytham, Lancashire, and is propelled by two Rolls-Royce Avon jet engines.

THE INCORPORATED PLANT ENGINEERS.

The annual dinner of the Incorporated Plant Engineers was held at the Café Royal, London, W.1, on Friday, January 30, the chair being taken by the President, Mr. G. A. Rooley, A.M.I.Mech.E., M.I.H.V.E. The dinner is officially described as "the first," indicating that, in future, it is to be an event in itself; previous dinners have been merely incidental to conferences in various parts of the country. The toast of "The Institution" was proposed by Sir John Maud, K.C.B., Permanent Secretary of the Ministry of Fuel and Power, who said that his Ministry was in no doubt regarding the importance of plant engineers in the common task of conserving natural resources and improving the efficiency of their use. He congratulated the Institution on its rapid growth to a membership of nearly 3,000, distributed over 18 active branches. The President, in reply, agreed that the Institution had done well in its seven years of existence, and appealed for the co-operation of managements in its future work. Mr. L. G. Northcroft then proposed the toast of "The New Honorary Members," namely, Sir Henry Wilson Smith, Sir Patrick Dollan, Mr. Harry Dawson, Principal F. H. Reid of the South-East London College of Technology, and Principal J. Wilson, of Birmingham College of Technology. Principal Wilson, in his reply, gave some particulars of the Plant Engineers' recently-inaugurated education scheme. The proceedings concluded with a toast to "The Guests," proposed by Mr. R. S. Davenport, and acknowledged by Sir Norman Kipping, Director-General of the Federation of British Industries.

JET-PROPELLED MILITARY TRANSPORT AIRCRAFT.—Vickers-Armstrongs Ltd., Weybridge, Surrey, are to start work on a prototype long-range military transport aircraft, the Vickers 1000, which is to be powered by four Rolls-Royce Conway by-pass engines. The Vickers 1000 will be a low-wing monoplane, with swept-back wing and tailplane. The wing layout is somewhat similar to that of the Valiant bomber aeroplane, and the engines will be completely enclosed in the wing. The aircraft will have a span of about 140 ft., an overall length of 146 ft., and a height of 38 ft. 6 in. It is designed to operate at high subsonic speeds. Vickers-Armstrongs Ltd. have also been working on a projected air liner, the V.C.7, also to be powered by Rolls-Royce Conway engines, for operation over trans-continental and trans-oceanic routes, with a seating capacity of 100 to 150 passengers. In appearance, the V.C.7 will be similar to the Vickers 1000.

LETTERS TO THE EDITOR.

THE GOVERNMENT AND THE IRON FOUNDRIES.

TO THE EDITOR OF ENGINEERING.

SIR,—May I ask you to correct two statements in your leading article, "The Government and the Iron Foundries," in your issue of January 23?

You state that this Council was "disposed to accept without serious objection the inclusion of iron foundries within the supervisory scope of the new Board." This is not so. From the earliest days—even before the issue of the White Paper—the Council was aware that it was the Government's firm intention not merely to denationalise the steel industry, but to bring the whole of the iron and steel industries within the supervision of a Board analogous to the former Forbes Board. That being so, the Council addressed itself, immediately and persistently, right up to the Minister's meeting on January 13 with the Associations principally affected, to the purpose of securing such amendments as would render the new and wider supervision less restrictive.

You go on to say that this Council accepted the Government's proposals "uncritically." This again is not so, and what has been stated above is proof of the fact, fully borne out by the amendments themselves. The whole of those of them of major significance were conceded by the Minister, chiefly upon the representations of this Council. They were accepted by the organisations represented at the meeting with Mr. Sandys, to which I have referred.

It should therefore be made plain that serious objection was taken by the Council of Ironfoundry Associations to many features of the Bill. At no time was the measure accepted in an uncritical spirit, a point well understood by the Minister himself.

Yours faithfully,
N. P. NEWMAN,
Chairman, The Council of Ironfoundry Associations.

Crusader House,
Pall Mall, London, S.W.1.
January 28, 1953.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read your leading article in your issue of January 23, and should like to express to you my grateful thanks for its entire contents. You have not, I am pleased to see, been swept off your feet by the persuasive arguments of the Minister of Supply. I feel, by the critical examination, fighting spirit, and fair conclusion which you have reached that you have performed a real service to all firms with iron foundries, and to industry as a whole.

Yours faithfully,
H. DESMOND CARTER,
Managing Director,
Crossley Brothers, Limited.

Openshaw, Manchester, 11.
January 28, 1953.

WILLIAM FROUDE, F.R.S., LL.D.

TO THE EDITOR OF ENGINEERING.

SIR,—I read with great interest of the scheme, to which you referred on page 115, *ante*, for the erection of a memorial at Torquay to William Froude, and perhaps I may be allowed to suggest that the inscription should give the exact dates and places of his birth and death. He was born on November 28, 1810, at Dartington Rectory, Devon, and died on May 4, 1879, at Simonstown, South Africa. His wife had died in 1878 and Froude, somewhat broken in health, accepted an invitation to join H.M.S. Boadicea for a cruise to the Cape. When about to return home he contracted dysentery and died at Admiralty House, Simonstown. He was buried in the naval cemetery. I have never seen a copy of the inscription on the tomb. As for Froude's connection with Torquay, in his Presidential address to the Devonshire Association in 1933, on "William Froude, His Life and Work," Sir Westcott Abell said that it was in 1859, after the death of his father, the Rev. Robert Hurrell Froude, with whom he had been living at Dartington, that Froude went to live at Paignton, but that in 1863 he "obtained a long lease of ground at Cockington, Torquay, from Mr. Mallock, and then he began building a house to his own design which was completed in 1867, and which was known as Chelston Cross." When, however, after the visit of Sir Edward Reed, it was decided to build an experimental tank, it was found that "the grounds at Chelston Cross were scarcely suitable and an additional plot of land separated from the house by Seaway-lane was bought, the tank constructed and put into use in 1871." The work done there by Froude and his son was the subject of a paper to the Institution of Naval Architects in 1941 by Mr. R. W. L. Gawn, which was reprinted in your columns during August, September and October of that year. It may be of interest to recall that, when William Denny (1847-87) built the Dumbarton Tank in 1883, he put an inscription on it which called Froude "the greatest of experimenters and investigators of hydrodynamics."

Yours faithfully,
"HISTORICUS."

January 31, 1953.

LABORATORY REPRODUCTION OF THE FIELD DENSITY OF SAND.

TO THE EDITOR OF ENGINEERING.

SIR,—I read with interest Professor Tschebotarioff's remarks, concerning my letter in ENGINEERING of November 28, 1952, on page 52 of your issue of January 9, about the chapter in his book concerning density and consistency, with special reference to the reproduction of the field density of sand.

In a book of the quality of *Soil Mechanics, Foundations and Earth Structures*, I felt that there is room for a technique of the type described in my letter. The process is not the result of a very recent research, though the procedure is not standardised by any organisation; it is in use and closes another gap in our knowledge. I quite understand that Professor Tschebotarioff intended to underline the difficulty of the determination of e in the field as the main trouble in the reproduction of the state of a sand deposit in a laboratory, but, at the same time, he does not show any technique of reproduction of that e, which, however inaccurately, was obtained by one of the existing methods in the field. Fig. 18-8 on page 579 of the book, mentioned in Professor Tschebotarioff's letter, indicates that something might be done about the reproduction of sand state in a laboratory, but neither the figure, nor the paragraph concerning the figure, describes the technique required. A student of soil mechanics, especially one who is not a specialist, may perhaps fail to get a clear picture of the problem and existing possibilities from the concerned paragraphs of his book.

As to the second part of my first letter concerning the reproduction of $e_{max.}$, which was not mentioned in Professor Tschebotarioff's reply, I should like to point out that our results are already affected by inaccurate sampling techniques in the field and we have to avoid further inaccuracy in the measurements of the maximum voids ratio in the laboratory.

Yours faithfully,
J. KOLBUSZEWSKI.

Department of Civil Engineering,
The University,
Edgbaston,
Birmingham, 15.
January 29, 1953.

FUEL EFFICIENCY.—The Ministry of Fuel and Power have issued their Fuel Efficiency Bulletin, No. 53, entitled *The Wetting of Slack to Assist Combustion*. It has long been known that the addition of water improves combustion and the bulletin gives a rational explanation of the fact; with the assistance of four graphs, notes are given on the degree of benefit likely to be achieved with different types of coal and grate, and concludes with advice on practical methods of slack conditioning. The bulletin is published by H.M. Stationery Office, York House, Kingsway, London, W.C.2. [Price 6d. net.]

OBITUARY.

SIR LEOPOLD SAVILE, K.C.B.

WE regret to record the death on January 28, at his home in London, of Sir Leopold Savile, a former Civil Engineer-in-Chief at the Admiralty and, in 1940-41, President of the Institution of Civil Engineers. He was 82 years of age.

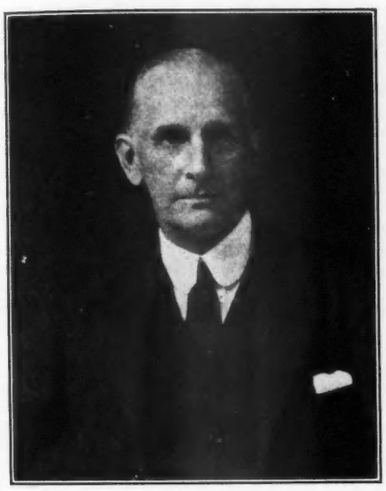
Leopold Halliday Savile was of Scottish descent, his father being Lieutenant-Colonel John Walter Savile, of Ballendrick, Perthshire. He was born on August 31, 1870, and was educated at Marlborough and at King's College, London. His pupilage as an engineer was served with Sir John Wolfe Barry and his partner, H. M. Brunel, by whom he was employed mainly on dock and harbour works, notably the entrance to Tyne Dock and the new docks constructed at Barry in the 'nineties, when there was keen competition in South Wales to develop coal exports. In 1896, he went to India as an assistant engineer on the construction of the Southern Punjab Railway and the Bengal North-Western Railway, but in 1898 he returned to England and to dock engineering, which was his principal activity for the rest of his professional life.

In 1902, he visited Australia to report on a proposed new harbour in New South Wales; and in the following year went to Singapore, on behalf of Messrs. Coode, Son and Matthews, the consulting engineers, to prepare a scheme for new harbour works. In 1904, after a short period as resident engineer on the extension of the Baker-street and Waterloo Railway, he went again to India, having been appointed deputy to the chief engineer of the Bombay Port Trust, Mr. P. G. Messent, M.I.C.E. He held this appointment for 15 years, during which he had charge of the construction of the Alexandra Dock, a 50-acre basin with an entrance lock and a dry dock, each 1,000 ft. in length. When, in 1919, Sir Alexander Gibb relinquished his position as Civil Engineer-in-Chief at the Admiralty, Savile was appointed to succeed him, with responsibility for all the naval dockyards, at home and overseas, and the construction of new docks for the Admiralty. He continued as Civil Engineer-in-Chief for 13 years, during which period the most important work carried out under his supervision was the construction of the naval base at Singapore.

Sir Leopold—who had received the K.C.B. in 1929, following the C.B. in 1925—retired from the Admiralty service in 1932 and then joined Sir Alexander Gibb—whose fellow pupil he had been, under Sir John Wolfe Barry—as a partner in the consulting firm of Sir Alexander Gibb and Partners, Westminster. In this capacity, his experience of dock and harbour work was of particular value, and in the course of the next 15 years he was personally concerned in a number of important schemes, including harbour works at Vizagapatam, Rangoon, La Guaira (Venezuela) and Burnie, in Tasmania; and—the largest undertaking of all, if the extensive preliminary investigations are taken into account—the Captain Cook graving dock at Sydney. The decision to construct this dock, in order to provide Australia with a dry dock capable of accommodating the largest warships and mercantile vessels afloat, was taken by the Commonwealth Government in 1939. Sir Leopold personally investigated 16 possible sites before recommending an area in Sydney harbour, opposite Garden Island, where the dock was eventually built. The work was begun in 1940 and completed in 1945, the dock being officially opened by the Duke of Gloucester in March of that year. The design was prepared by Sir Alexander Gibb and Partners, who also supervised its construction, including the reclamation of 35 acres of ground between the mainland and Garden Island. It is 1,133 ft. long and 148 ft. wide.

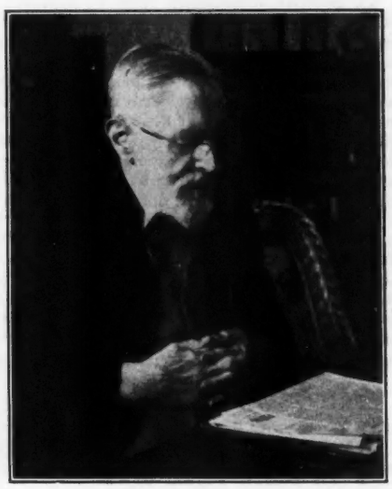
While the Captain Cook dock was undoubtedly his greatest work and it will be as a dock engineer that he will be chiefly remembered, Sir Leopold was also responsible, as a consultant, for a variety of other large civil-engineering schemes, including the bridge over the river Forth at Kincardine, and the civil engineering part of a number of large electric-power stations, among them being those at Ipswich, Littlebrook, Earley, Meaford and

Bromborough. He was admitted an associate-member of the Institution of Civil Engineers in 1895, transferred to Member in 1914, and, after a number of years on the Council, became President in 1940. His presidential address, which was reprinted in our 150th volume, dealt mainly with the engineering of harbours and was unusual in that he took advantage of war-time restrictions on references to works of current military importance to survey the design and construction of harbours of the pre-Christian era. Among other awards, he received the George Stephenson Gold Medal of the Institution in 1925 for a paper on "The Demolition of the Harbour and Defence Works of Heligoland." As mentioned above, he retired from his partnership in 1947, but he continued to act as a consultant to



SIR LEOPOLD H. SAVILE, K.C.B.

PROFESSOR C. J. HAWKES, O.B.E.



MR. RHYS JENKINS.

his firm almost until his death. He was a Fellow of King's College, London, an associate of the Institution of Naval Architects and a member of the Institution of Engineers, Australia; and, among other appointments, served for many years on the International Consultative Committee on the Suez Canal and as a British representative in the Permanent International Association of Navigation Congresses.

PROFESSOR C. J. HAWKES, O.B.E.

WE also regret to record the death, on January 30, of Engineer Commander C. J. Hawkes, who, for 26 years, was Professor of Engineering at King's College, University of Durham. He was 72 years of age and, since his retirement in 1946, had been living at Eastbourne.

Charles John Hawkes was born on April 22, 1880. He received his general education at Sir J. Williamson's school at Rochester and entered Chatham Dockyard in 1895 as an engineering apprentice, remaining there until 1899. He then attended the City and Guilds College, London, for a year, proceeding thence to the Royal Naval College at Greenwich, from which he passed out in 1903 with the rank of engineer sub-lieutenant. He was appointed to H.M.S. Montagu, a battleship of the King Edward VII class; but this, his first seagoing commission, was only short, as he was transferred to Sheerness Dockyard in the following year as assistant to the Chief Engineer. In 1907, he was appointed to the staff of the Director of Dockyards, at the Admiralty, and, in 1908, went back to sea in the cruiser Black Prince for a three-years' commission. His short sojourn in the Dockyards department had evidently impressed the then Director, Sir James Marshall, who, in 1910, applied for Hawkes to be returned to that department; but it was decided that the vacancy, which was caused by the retirement of an engineer captain, should be filled by an officer of greater seniority, Hawkes being, at that time, still an engineer lieutenant. He was appointed instead to the staff of the Engineer-in-Chief, Engineer Vice-Admiral H. J. Oram.

This last-mentioned appointment proved to be a turning point in his naval career, for he did not again go to sea, but was selected for a succession of special tasks of an increasingly technical and scientific nature. He was joint secretary to the Royal Commission on Fuel and Engines from 1912 to 1914. He returned to the Engineer-in-Chief's staff on the outbreak of war, but in 1915 became assistant secretary to the Board of Invention and Research, where his work brought him special promotion to Engineer Commander and a personal letter from Admiral of the Fleet Lord Fisher which ended "I look forward to your being Engineer in Chief of the Navy." His next post was the highly responsible one of Superintendent of the Admiralty Engineering Laboratory on its establishment in 1917. He held it for three years, and might then have returned to the Admiralty had he not been appointed, on the recommendation of the Engineer-in-Chief (Sir George Goodwin, who had succeeded Sir Henry Oram in that office), to the vacant chair of engineering at Newcastle. It was a position for which he was well suited, though he would have preferred to remain in the Navy. At that time, however, a rule was in force that there was to be no promotion for naval officers whose service during the 1914-18 war had been only on shore. Throughout the war, Hawkes had held shore appointments. Seeing no chance of promotion, he accepted the professorship. The restriction on promotion was removed two months later, but by then he had resigned from the Navy.

Professor Hawkes was a member of the Institution of Naval Architects and served on the Council for a number of years. He was also a member of the Institution of Mechanical Engineers; a Fellow of the North East Coast Institution of Engineers and Shipbuilders, of which he was President for two years, from 1936 to 1938; and an honorary member of the Society of Naval Architects and Marine Engineers, New York.

MR. RHYS JENKINS.

WE referred in last week's issue to the death of Mr. Rhys Jenkins, M.I.Mech.E., formerly senior examiner at the Patent Office, but much more widely known for his original researches into the history of engineering and its allied sciences and industries. We are now able to supplement that necessarily brief notice with an outline of his career and work, together with a portrait, taken on his 90th birthday.

Rhys Jenkins was born in the village of Mountain Ash, Glamorganshire, on September 29, 1859; so that he was in his 94th year, and not his 93rd, as we stated last week. His father, Thomas Jenkins, came from Neath, whither he returned shortly afterwards; it was in Neath, therefore, that Rhys obtained his schooling. He had his introduction to engineering in 1874, when he was apprenticed to Richard Nevil, engineer and ironfounder, whose works was at Llanelly. He served for four years, and remained for two more as a draughtsman; an ambitious one, evidently, for he became a graduate of the Institution of Mechanical Engineers in 1880, while still with Nevil. He then went to Leeds, to the drawing office of John Fowler and Company, and then to Greenwood and Batley, Limited, concurrently attending evening classes at the Yorkshire College, now the University of Leeds. In December, 1881, he went to Richard Hornsby's works at Grantham, in search of wider experience, and in June, 1883, to Marshall, Sons and Company, at Gainsborough. A year later—in July, 1884—he was successful in passing the examination for an appointment to the staff of the Patent Office, where the next 36 years of his long life were spent, first as an assistant examiner and eventually as senior examiner. He retired in 1920, and lived for a number of years at Newbury, Berkshire; but after the death of his wife he removed to Hastings, which was his home until he died.

Almost immediately on his appointment, Jenkins began the great work of systematically collecting manuscripts, notes and transcripts of historical interest, the careful collation and publication of which established him as an authority more than half a century ago. His first work of note was *Power Locomotion on the Highway*, which appeared in 1896. It was followed six years later by *Motor Cars and the Application of Mechanical Power to Road Vehicles*, which, like the previous work, was a reference list of sources and has provided many subsequent researchers with a basis for their work. He contributed a large number of historical surveys to technical and other journals, on a remarkable variety of subjects, and all characterised by the painstaking attention to detail and the breadth of scholarship that were the hallmarks of his work throughout his life.

On the foundation, in 1920, of the Newcomen Society for the Study of the History of Engineering and Technology, he joined it immediately, and almost the whole of his subsequent published researches appeared in that Society's *Transactions*. He was President in 1924-25, and continued to

contribute valuable papers for many years after he had retired from active participation in the direction of the Society. His services were recognised in a way which caused him much gratification when, in 1936, the Council caused the miscellaneous papers of his pre-1920 era to be collected and issued as an "Extra Publication." The edition was limited to 300 copies—unfortunately, as it proved, for each one could have been sold many times. It was, perhaps, the most popular of his writings in the breadth of its appeal, though the most impressive was probably the Watt Centenary memorial volume, *James Watt and the Steam Engine*, published in 1927, in which he collaborated with the late Dr. H. W. Dickinson.

It has been mentioned that Jenkins joined the Institution of Mechanical Engineers as a graduate in 1880. There was no associate-member grade in those days, so, when he was advanced in status, it was to that of member, which he attained in 1886. Whether, at his death, he was actually the senior member in point of duration of membership, we do not know; it is possible that he was, for he was certainly among the three most senior several years ago. He rarely attended meetings of the Institution after his retirement from the Patent Office, and was not often seen at those of the Newcomen Society after his removal to Hastings; but his influence was still potent, for it was his widely-ranging mind which suggested the subjects of many papers written by others, and always he was ready with helpful notes for inclusion and, very often, with references to sources where most inquirers would not have thought of looking. Though latterly feeling the weight of his years, he continued to pursue his historical researches until a few weeks before his death, which occurred in his sleep on January 27.

PROFESSOR N. A. V. PIERCY.

WE record with regret the death of Professor N. A. V. Piercy, which occurred at the age of 62 on Sunday, February 1, 1953, at his home at 3, King's Bench-walk, Temple, London, W.C.2.

Norman Augustus Victor Piercy was born in London on August 10, 1891. He was educated at Hampton Grammar School. Between 1908 and 1913 he was apprenticed to Yarrow and Company, Scotstoun, and in 1913 he obtained an honours degree (London) in engineering. Between 1914 and 1918 he designed aircraft at Shoreham aerodrome and carried out experiments, in a wind-tunnel of his own design, at East London College, for the Admiralty, Airboard and Ministry of Munitions. In 1919, he was appointed head of the Aeronautical Department of East London College (now Queen Mary College). He obtained his doctorate in engineering in 1920. In the period between the world wars, his research work was mainly concentrated on the analytical investigation of aerofoils. Between 1934 and 1949 he was reader in aeronautics to the University of London; and from 1939 to 1944 he was lecturer in aeronautics and fluid dynamics at Cambridge University, being appointed a Leverhulme Research Fellow in 1940. Since 1949 he had been Professor of Aeronautical Engineering in the University of London, Queen Mary College.

Dr. Piercy was a member of the Institution of Civil Engineers (1936), the Institution of Mechanical Engineers (1934) and a Fellow of the Royal Aeronautical Society (1928). The status of aeronautical engineering training in the United Kingdom owes much to Dr. Piercy. He was for many years one of the principal advisers to the Royal Aeronautical Society on education, and it was largely as a result of his efforts that aeronautical engineering was introduced into the Higher National Certificate examination syllabus of the Board of Education and in the B.Sc. degree examinations of the University of London. He was a member of the Council of the Royal Aeronautical Society from 1935 to 1939. He was the author of books on *Aerodynamics*, an advanced text-book for university students, published in 1937 and revised in 1947; *Elementary Aerodynamics*, a non-mathematical treatment published in 1944; aeronautical articles in the *Encyclopaedia Britannica* and *Chambers Encyclopaedia*, many papers read before learned societies, and various reports to the Aeronautical Research Council.

JOINT CONFERENCE OF N.A.T.O. ADVISORY GROUP FOR AERONAUTICAL RESEARCH WITH THE "ASLIB" AERONAUTICAL GROUP.

IN order to work out ways for improving aeronautical information services throughout the N.A.T.O. countries, the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organisation are to take part jointly in the "Aslib" Group's second annual conference, announced on page 91, *ante*. The Conference will be held from Friday, March 27, until Tuesday, March 31, at the College of Aeronautics, Cranfield. Delegates will assemble on the Friday evening. The annual general meeting of the Aslib Aeronautical Group will be held early on Saturday morning, followed by a discussion on the Group's activities and other matters of general interest. On Saturday afternoon there will be a session on "Cataloguing Aerodynamic Data," with special reference to a scheme initiated by the National Luchtvaart Laboratorium of Amsterdam. The conference dinner will be held on Saturday evening, preceded by a cocktail party. On Sunday, there will be a full-day discussion on a common international system for indexing, abstracting and cataloguing all aeronautical reports. For this meeting, all N.A.T.O. member States have been asked to give their views on these problems and to contribute papers describing the present practice in their own countries. A film show will be arranged for Sunday evening. Monday, March 30, will be devoted to further discussion of points arising from the session on Sunday. The final meeting, on Tuesday, March 31, is for A.G.A.R.D. delegates only, to decide on the action to be taken on the matters discussed. The chairman on Sunday, Monday and Tuesday will be Professor A. A. Hall, Director of the Royal Aircraft Establishment. The conference fee will be 25*s*., including preprints, membership of the College club, and transport from Bedford railway station. The charge for board and accommodation will be 25*s*. per day. Further particulars may be obtained from Mr. C. W. Cleverdon, College of Aeronautics, Cranfield, Bletchley, Buckinghamshire.

AIDS TO ROAD TRAFFIC FLOW.

In a paper read before the Institution of Civil Engineers on Tuesday, February 3, Mr. R. A. B. Smith, M.C., A.M.I.C.E., dealt with those aids to traffic flow which might with advantage be put into practice, and which would not involve major construction. Speaking of the Marble Arch and Oxford-circus areas in London, however, he said that these two bottle-necks caused traffic to pile up for long distances, and that, in his view, the only cure was reconstruction; but at both places a traffic census would probably show that the provision of traffic subways in one direction only would so reduce congestion above ground as to give a reasonably smooth flow of traffic even in peak hours. He also suggested that eight-storey garages might be built at Battersea, Earl's Court, Notting Hill-gate and other centres to serve as termini for private cars coming from the western suburbs, where their passengers could transfer to 'buses which would run into the garages: one 'bus would carry the passengers of 20 cars, and, of course, would occupy much less road space in inner London. The design of curbs, 'bus bays and roundabouts came in for criticism, as also the existence of "halt" signs where there were clear views; at the same time, he pointed out that, whereas the first essential at road junctions was good sight-lines in every direction, it was surprising how few road junctions provided them. He also suggested that alternative routes might be made more obvious by giving distinguishing coloured backgrounds to the name plates on different routes. From the operators' point of view, places like Stamford, on the Great North-road, added thousands of pounds to the cost of transport—a cost which ultimately fell upon the consumer; if 40 lorries were each delayed for a quarter of an hour, that was equivalent to one lorry being off the road for a whole day.

HYDRO-ELECTRIC DEVELOPMENTS IN SCOTLAND.

THE Secretary of State for Scotland (the Rt. Hon. James Stuart) has approved a scheme of the North of Scotland Hydro-Electric Board for the development of water power in the Breadalbane area of the country. This development, which will be one of the Board's major projects, will utilise the resources of upper Glen Lyon, Loch Daimh and Loch Giorra as well as streams in Glen Lochay and Glen Dochart. Use will also be made of the head waters of the rivers Almond and Lednock, as well as of the waters of Lochan Breaclaich, and other streams to the south of Loch Tay; the waters of Loch Earn and tributaries to the south of the River Earn; and the head waters of Monachyle Burn. The installed capacity of the generating plant will be about 88·5 MW and the estimated annual output 304 million kWh.

The works will include the construction of a dam, 96 ft. high, across the River Lyon, near Lubreoch. This will enlarge the capacity of Loch Lyon, to which further water will be supplied from Glen Lochy through an aqueduct. A generating station will be built into the dam from which water will be discharged down river. A second dam, in which a fish pass will be incorporated, will be built near Stronuich and will form a smaller loch, on the north side of which there will be a second generating station. This station, in turn, will discharge into a tunnel through which water will be transmitted to a third station near Murlaganmore in Glen Lochay. Lochs Daimh and Giorra will be enlarged and united by building a dam 92 ft. high across the Allt Conait; and the water from this reservoir will be led to a generating station at Stronuich. A third reservoir will be created by damming the Monochyle Burn and will supply a generating station on the River Dochart, near Luib railway station. A dam about 60 ft. high will be built in the St. Fillans area, so that Lochan Breaclaich will be converted into a reservoir and water led thence to a generating station in Glen Lednock. A new loch will be formed by building a dam across the River Lednock, near Bovaine, into which water from the River Almond and other streams will be diverted. This reservoir will supply another station near St. Fillans, while a station near Dalchonzie will be fed from Loch Earn through a tunnel.

Before the scheme was approved a number of recommendations were made by the Amenity Committee and accepted by the Hydro-Electric Board. The Fisheries Committee also made detailed recommendations, not all of which were accepted, but the Secretary of State is satisfied that the fisheries interests will be reasonably protected. Compensation water is to be provided under an agreement with the Tay District Salmon Fisheries Board, and additional river watchers both during the construction of, and, if necessary, after the completion of, the works, will be appointed. Deleterious effluent is not to be discharged into the rivers affected by the scheme and proper sewage-disposal plant is to be constructed for dealing with the outfall from houses and camps. Finally, the Board have agreed to submit plans for the fish passes that are to be constructed for the consideration of the Fisheries Committee.

NEW LABORATORIES FOR HOOVER (WASHING MACHINES), LIMITED.—An extensive building and development programme nearly completed at the factory of Hoover (Washing Machines), Ltd., Merthyr Tydfil, Wales, includes new laboratories to carry out experimental work hitherto performed in the main Hoover laboratories at Perivale, Middlesex. The new laboratories, which were opened recently, are divided into chemical and metallurgical sections. In the chemical laboratory the properties of plastic moulding powders, electro-plating constituents, resins, paints, etc., are investigated, and the various chemical processes used in manufacture are checked. The metallurgical laboratory is equipped with a Denison tensile-testing machine, a Hounsfield tensometer, two thermostatically-controlled Gallenkamp electric ovens for heat treatment, a Cooke, Troughton and Simms universal photographic microscope, and a Hilger Spekker photo-electric absorptiometer for carrying out analysis.

ELECTRIC STORAGE SPACE-HEATER.

GENERAL ELECTRIC COMPANY, LIMITED, LONDON.

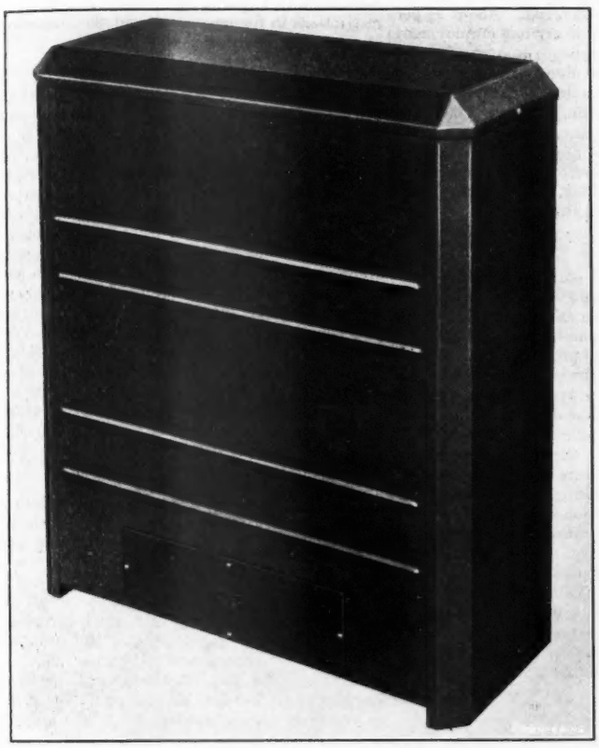


FIG. 1. GENERAL VIEW OF HEATER.

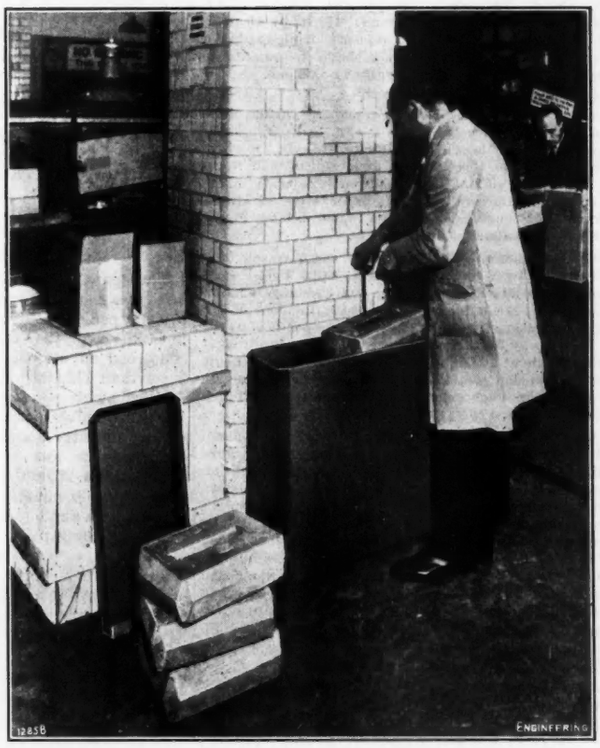


FIG. 2. CONCRETE STORAGE BLOCKS.

ELECTRIC STORAGE SPACE-HEATER.

THE General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2, have designed an electric space-heater, which is controlled by a time switch so that it can be charged during the night, and heat thus stored utilised during the following day. It will be useful, therefore, where special cheap rates are available to domestic consumers for current taken during off-peak hours, or in factories in which the cables are fully loaded during the day. The external appearance of the new type is shown in Fig. 1. It consists of concrete blocks and a heating element, mounted in a sheet steel case. The maximum charging period is eight hours and the heat output, expressed as a percentage over the 24 hours, is 35 per cent. during this charging period, 56 per cent. during the day when the current is switched off and 9 per cent. during the last eight hours. The heat emitted during the charging period provides a comfortable room temperature at the start of the day. The heater weighs 480 lb. and, to overcome the difficulty of transporting and installing so heavy a weight, the concrete mass is divided into ten blocks, as shown in Fig. 2, which can be placed in the heater by special lifting keys after it has been erected and connected. Handling and transport are further simplified by packing the heater in three sections, namely, the body, the elements and the concrete blocks. The heater is 29 in. high by 25 in. wide, by 11 in. deep and the electrical loading is 1·5 kW.

DISCUSSION ON BORON IN STEEL CANCELLED.—The Iron and Steel Institute informs us that a special meeting which was to have been held at their offices, 4, Grosvenor-gardens, London, S.W.1, on Wednesday, February 18, to discuss recent developments in the United States in the manufacture and use of boron-bearing steels, will not now take place. The meeting has had to be cancelled because Mr. N. F. Tisdale and Mr. H. B. Knowlton, the authors of the two papers which were to have been read, could not attend.

THE NATIONAL RESEARCH DEVELOPMENT CORPORATION.

SOME indication of the kind of work carried out by the National Research Development Corporation is given in their third annual report, for the year July 1, 1951, to June 30, 1952, published recently by H.M. Stationery Office, Kingsway, London, W.C.2 (price 9*d*. net). The previous report, a summary of which was given on page 212 of our 173rd volume (February 15, 1952), set out the policy of the Corporation in carrying out its function of developing and exploiting inventions. During the year 1951 to 1952, 1,027 inventions were communicated to the corporation, of which 491 were from Government departments and research councils, 455 from private firms and individuals, 53 from universities, and the remainder from Commonwealth official organisations, nationalised industries, industrial research associations and charitable organisations. A total of 445 patents and patent applications were assigned to the Corporation, bringing the total holding to 1,736, of which 960 were from the United Kingdom, the majority being contributed by Government departments and research councils; the other 776 were overseas patents and applications. The Corporation is a party to 199 licence agreements, most of which are not yet earning revenue.

During the year, details of 361 inventions suitable for commercial exploitation were circulated by the Corporation to industrial firms. As a result of this, together with 100 inquiries brought forward from the previous year, 78 cases have resulted in licence negotiations, 31 of which have been completed. There were 101 cases still under discussion at the end of June. Some 200 inventions from Government departments and 80 from universities were not suitable for straightforward exploitation, and were under constant individual attention by the Corporation; nine of these have now become the subject of completed licence agreements, and discussions with industrial firms were still in progress on 32 of them at the end of the year.

Fifteen development projects, in which the Corporation have undertaken to pay for development expenditure from their own funds, have been sponsored during the first three years of the Corporation's life. Among these may be mentioned a light steam engine proposed by Sir Harry Ricardo, for use in undeveloped regions of the world for the operation of boiler plant designed to be fired with low-grade fuel. It may be recalled that the Report of the Committee on the Utilisation of Solar Energy, reprinted in ENGINEERING, vol. 174, pages 607, 645 and 679 (1952), called attention to the desirability of developing a small steam engine, for use as a prime mover in undeveloped countries, which could be fired by vegetable matter.

Electronic digital computers form one of the principal projects of the Corporation; 99 such inventions have been assigned to the Corporation, and 479 patents have been applied for in respect of 74 of them in ten foreign countries. Some of the leading firms in the field have negotiated, or are negotiating, licences to construct them. The Corporation have given a contract for the supply of four calculating machines similar to that designed by Professor F. C. Williams, F.R.S., and installed at Manchester University, and are also entering into a contract for the supply of a much smaller prototype machine based on the development of special techniques. Other examples of inventions under development by the Corporation include a photogrammetric plotting instrument, invented by Colonel E. H. Thompson, Professor of Surveying at University College, London, with some novel design features for converting stereoscopic aerial photographs into contour maps; such machines, which are very costly, are not at present made in the United Kingdom. The Corporation are also assisting the National Physical Laboratory in the development of diffraction gratings for spectroscopes, invented by Sir Thomas Merton, F.R.S. Two industrial instrument firms have already taken out licences under the Corporation's patent rights for these inventions, and it is expected that export orders will follow.

LAUNCHES AND TRIAL TRIPS.

S.S. "VACUUM PIONEER."—Single-screw oil tanker, built by the Grangemouth Dockyard Co., Ltd., Grangemouth, for the Vacuum Oil Co., Ltd., London, S.W.1, for the carriage of lubricating oils from Coryton to Birkenhead. Managers: Stephenson Clarke, Ltd., London, E.C.3. Main dimensions: 245 ft. by 40 ft. by 16 ft. 6 in. Direct-acting oil-fired triple-expansion steam engine, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Wallsend-on-Tyne. Speed, 11¼ knots. Launch, December 18.

M.S. "POLARTANK."—Single-screw oil tanker, built and engined by Barclay, Curle & Co., Ltd., Whiteinch, Glasgow, for Meisom and Meisom, Larvik, Norway. Second vessel of three. Main dimensions: 566 ft. by 72 ft. 6 in. by 40 ft. 6 in.; deadweight capacity, about 19,000 tons. Barclay Curle-Doxford six-cylinder airless-injection oil engine, developing 8,000 b.h.p. Speed, 15¼ knots. Launch, December 20.

S.S. "APPLEDORE."—Single-screw cargo vessel, built and engined by William Gray & Co., Ltd., West Hartlepool, for the Maritime Shipping and Trading Co., Ltd. (Managers: Michalinos & Co., Ltd.), London, E.C.2. Main dimensions: 431 ft. between perpendiculars by 57 ft. 6 in. by 38 ft. 3 in. to shelter deck; deadweight capacity, about 10,000 tons on a draught of 26 ft. 6½ in. Triple-expansion steam engine, working in conjunction with a Bauer-Wach exhaust turbine, and three oil-fired boilers. Speed, 11¼ knots. Launch, December 30.

S.S. "BOHEME."—Single-screw cargo vessel, accommodating three passengers, built by Bartram and Sons, Ltd., Sunderland, for Rederi A/B Wallenco, Stockholm. First vessel of two. Main dimensions: 445 ft. between perpendiculars by 62 ft. by 40 ft. 2 in.; deadweight capacity, about 10,300 tons on a draught of 27 ft. Triple-expansion reheat reciprocating steam engine, developing 3,900 i.h.p. in service, and three multitubular oil-burning boilers, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Sunderland. Trial speed in ballast condition, 14·7 knots. Trial trip, January 6.

M.S. "GUILDFORD."—Single-screw collier, built by the Burntisland Shipbuilding Co., Ltd., Burntisland, Fife, for the South Eastern Gas Board, Croydon, Surrey. Third vessel for these owners. Main dimensions: 264 ft. 6 in. between perpendiculars by 39 ft. 5 in. by 18 ft. 6 in.; deadweight capacity, 2,875 tons on a draught of 17 ft. 1½ in.; gross tonnage, 1,871. Eight-cylinder marine Diesel engine, developing 1,150 b.h.p. at 225 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Trial trip, January 15.

M.S. "SILVERBROOK."—Single-screw oil tanker, built by Smith's Dock Co., Ltd., South Bank-on-Tees, for the Silver Line, Ltd., London, E.C.2. Main dimensions: 528 ft. 10 in. overall by 69 ft. 6 in. by 38 ft.; deadweight capacity, about 16,500 tons on a draught of 29 ft. 9 in. Hawthorn-Doxford five-cylinder two-stroke opposed-piston oil engine, developing 5,000 b.h.p. at 110 r.p.m. in service, constructed by R. and W. Hawthorn, Leslie & Co., Ltd., Newcastle-upon-Tyne. Service speed, 13 knots. Launch, January 15.

M.S. "JERSEY SPRAY."—Single-screw cargo vessel, built and engined by William Doxford and Sons, Ltd., Sunderland, for Morel, Ltd., London, E.C.3. Main dimensions: 420 ft. between perpendiculars by 57 ft. 9 in. by 28 ft. 6 in.; deadweight capacity, 9,100 tons on a draught of about 26 ft. Four-cylinder opposed-piston oil engine, developing a service speed of about 13 knots. Launch, January 15.

M.S. "GRINDEFJELL."—Single-screw cargo vessel, built by John Crown and Sons, Ltd., Sunderland, for Olsen and Ugelstad, Oslo, Norway, for service on the Great Lakes, Canada. Main dimensions: 250 ft. between perpendiculars by 42 ft. 6 in. by 26 ft. to upper deck; deadweight capacity, 2,750 tons on a draught of 18 ft. 3 in. Two Clark-Sulzer Diesel engines coupled to a single shaft, constructed by George Clark (1938), Ltd., Sunderland. Launch, January 16.

S.S. "HULL CITY."—Single-screw trawler, built by Cochrane & Sons, Ltd., Selby, Yorkshire, for Consolidated Fisheries, Ltd., Grimsby. Main dimensions: 178 ft. between perpendiculars by 31 ft. by 16 ft. 3 in.; gross tonnage, 700. Triple-expansion steam engine, developing 1,200 i.h.p., and one oil-burning boiler, constructed by Amos and Smith, Ltd., Hull. Launch, January 17.

M.S. "CORBURN."—Single-screw cargo vessel, built by the Goole Shipbuilding and Repairing Co., Ltd., Goole, for Wm. Cory and Son, Ltd., London, E.C.3. Main dimensions: 258 ft. by 39 ft. 3 in. by 19 ft.; deadweight capacity, 2,700 tons. Eight-cylinder Diesel engine, developing 1,040 b.h.p. at 205 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Launch, January 17.

M.S. "JANOVA."—Single-screw oil tanker, built and engined by Harland and Wolff, Ltd., Belfast, for Anders Jahre & Co., Sandefjord, Norway. Main dimensions: 540 ft. by 73 ft. by 39 ft. 3 in.; deadweight capacity, 18,500 tons. Harland-B. and W. six-cylinder oil engine. Trial trip, January 28 and 29.

LABOUR NOTES.

STOPPAGES of work arising from industrial disputes in the United Kingdom during 1952 resulted in a loss of 1,793,000 working days at the establishments where the stoppages occurred. About 1½ per cent. of the total population in civilian employment were involved in these stoppages and the loss of time for each employee involved averaged rather more than five working days during the year. The total number of days lost during 1951 was 1,694,000. Of the 1,793,000 working days lost during 1952, according to the *Ministry of Labour Gazette* for January, about 1,770,000 were lost through stoppages beginning in that year, and about 23,000 through stoppages which had started in the previous year.

The aggregate number of employees involved in last year's stoppages was 416,000, compared with 379,000 persons concerned in stoppages in progress in 1951. Of the total number of workpeople concerned in stoppages in progress in 1952, no fewer than 112,000 were thrown out of work at the establishments where the stoppages arose, without being themselves parties to the disputes. The coal-mining industry accounted for about one-third of the aggregate loss of time through stoppages in 1952. Some 26,000 days were lost in April and May by 6,000 miners, following the refusal of the management at the colliery concerned to allow men who were being paid extra allowances for working in water to leave the pit early. Delay in settling a wage claim by colliery deputies led to a stoppage of work at various pits in Yorkshire during June and in this dispute approximately 42,000 working days were lost by about 18,000 miners. Altogether, there were 1,225 stoppages in the coal-mining industry during 1952, and, in them, 273,600 miners took part and lost 661,000 days' work.

In the shipbuilding and ship-repairing industry, there were 62 stoppages last year and, in them, 13,500 persons took part and lost 87,000 working days. In the metal-manufacturing industry, there were 31 stoppages, in which 6,700 persons were concerned and 31,000 working days were lost; while, in the engineering group of industries, there were 62 stoppages, in which 23,900 workpeople were involved and 185,000 days were lost. Strikes in the vehicle-building industry were even more severe. In this industry, there were 47 stoppages, involving 38,900 persons and causing the loss of 469,000 days. A stoppage of work in March and April by more than 16,000 apprentices in the metal-manufacture, shipbuilding, general-engineering, electrical-engineering, vehicle-building and other manufacturing industries, due to an alleged delay in the settlement of their claim for an increase in wages, resulted in a loss of about 194,000 working days.

A considerable number of wage increases, applicable to many classes of workpeople, are reported to have taken effect during December last. Some 566,000 workpeople in the United Kingdom received increases in their full-time weekly wages during that month and these were estimated to amount to about 110,000*l.* a week net. The increases principally affected workpeople engaged in motor-vehicle retailing and repairing, in the iron and steel industry, and in hosiery manufacture in the Midlands. There was a decrease of about 4,000*l.* in the weekly wages of 29,000 persons, principally those engaged in carpet manufacture and in the production of shoes and slippers, owing to the operation of sliding-scale arrangements based on the interim index of retail prices.

A sharp decline occurred during the twelve months ended July 31, 1952, in the number of situations available to young persons in the area covered by the London County Council. In July, 1952, only 11,262 vacancies were registered with the Council's Youth Employment Service, compared with 18,936 vacancies in July, 1951. The number of juveniles claiming unemployment benefit in the area rose from 1,900 in 1950-51 to 6,400 in 1951-52. The clothing and furniture industries and, to a somewhat less extent, the engineering industry, were those principally concerned in the deterioration of employment among the young. There was a general decline in clerical employment, owing to reductions in exports, the cutting of food imports, restrictions in foreign travel, and the increasing use of mechanised methods.

As a result of these conditions, employers throughout the area have been enabled to raise the standard required from their juniors, especially in such matters as appearance, bearing and speech. High wages have remained an almost irresistable attraction for many young people, according to the annual report of the L.C.C. Youth Employment Service for the year ended 31st July, 1952, issued last Monday. Owing to the increasing difficulty of finding employment for their children, more parents made use of the Service. None the less, only about 40 per cent. of the parents concerned attended career-guidance interviews with their children during the year. In the twelve months ended July last, registrations totalled 47,591, an increase of 5,007 on the number registered during the previous twelve months. The Service was able to place 44,062 of these juveniles during 1951-52, an increase of 5,028 on the total for the previous period.

It is recorded that, among those for whom work was found, were about one hundred coloured young people. There were no really outstanding difficulties in securing these placings, but extensive canvassing was necessary before the boys and girls concerned obtained satisfactory employment, mainly because some employers felt that customers or fellow workpeople might object. Reference is also made to the employment difficulties which have been caused by the introduction of the General Certificate of Education. In many cases, young people have taken advantage of the new regulations to drop subjects for which they have no special liking, only to find at a later date that a pass in these subjects was an essential requirement for entering a particular trade or profession.

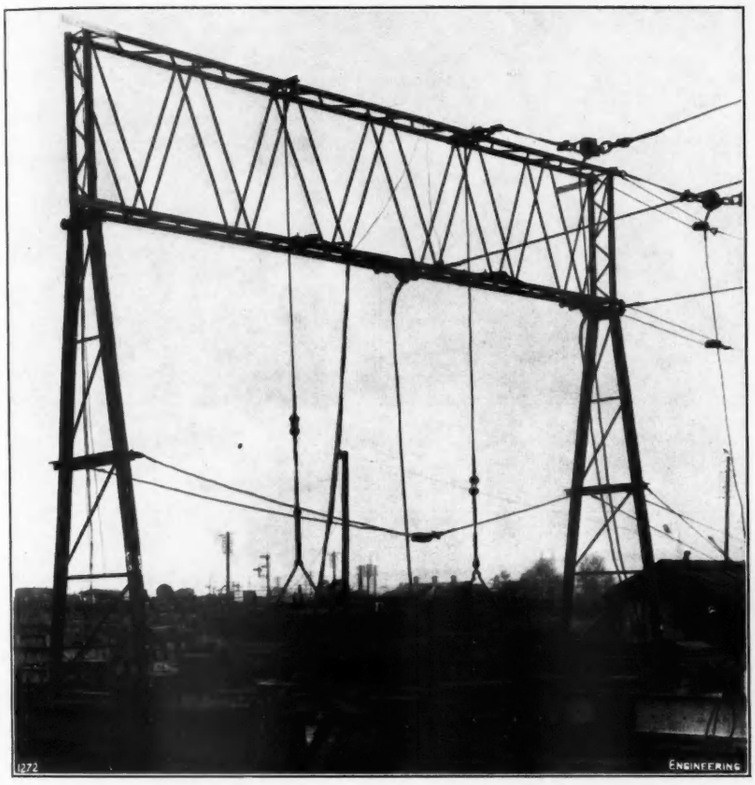
Agreement has been reached between the National Coal Board and the National Union of Mineworkers that June 2, Coronation Day, shall be a paid holiday for the 700,000 workpeople in the coal-mining industry. Similar arrangements are under consideration regarding the three million employees in the engineering and shipbuilding industries. In most cases, local agreements in these industries provide that employees may also take June 1 as a paid holiday, provided that they work on Whit-Monday or on some other recognised national holiday.

Claims for increases in the salaries of their members have been put forward during the past few days by the Association of First Division Civil Servants and the Society of Civil Servants, which represents the executive grades of the Service. It is reported that these claims are not based on the recent upward trend in salaries and wages outside Government employment, but to the level of Civil Service salaries in the pre-war period.

Protests against the severe handicaps which high taxation imposes upon industry and individuals alike were made in a memorandum submitted by the Scottish Council of the Federation of British Industries to the Royal Commission on Scottish Affairs, on Tuesday last. The Council state that the Federation is convinced that, until the present load of taxation is lightened, no real progress can be made towards restoring and improving Britain's economic position and power, and, with it, the country's standard of living. To this end, major reductions in the level of Government expenditure are essential. The burden of taxation is weighing down industry's enterprise and restricting its efforts to an extent that is intolerable. To reduce the burden is the most important task before the Government.

WELDED TUBULAR STEEL GANTRY.

TUBEWRIGHTS, LIMITED, NEWPORT.



WELDED TUBULAR STEEL GANTRIES.

THE possible use of welded tubular-steel gantries to support the overhead line equipment required for the electrification of railways formed part of the discussion following the presentation of a paper read recently before the Institution of Electrical Engineers.* Particular mention was made then of the installations on the Liverpool Street to Shenfield line of the Eastern Region, British Railways, and also of the work now being done by the same Region on the electrification of the Manchester-Sheffield line. It will be remembered that British Railways are committed, in all but certain specified areas, to the installation of overhead high-tension lines for new schemes of electrification, rather than to the use of the third or fourth rail systems of the Southern Region or London Transport. The decision to use overhead lines was taken by a committee appointed by the Railway Executive and London Transport jointly, and the reasons underlying the decision were set out in a report published in 1951.†

The use of welded-tube gantries has been the subject of a recent investigation, made under the aegis of British Railways, which culminated in a test on a prototype gantry designed, and built at their Newport works, by Tubewrights, Limited, 25, Buckingham-gate, London, S.W.1 (a subsidiary of Stewarts and Lloyds, Limited), to a specification laid down by British Railways. The test was conducted in the works of Painter Brothers, Limited, Hereford, and was made to afford a comparison between the proposed welded-tube structure and a conventional frame fabricated from rolled-steel joists, an example of which was tested under similar conditions in 1938. The accompanying illustration shows the prototype gantry mounted on the test bed and the arrangements that were made for applying the test loads; where convenient, the dead weight was placed in panniers or, for the smaller transverse loads, hung on cables passing over pulley blocks; heavier loads were generated in 10-ton dynamometers. Deflection of the structure was observed by taking sights on divided scales fixed to the gantry; the scales, which can be seen in the illustration, were located on the levels of the upper and lower booms of the bridge girder; those used for observing transverse deflections are above the left-hand legs, those used for longitudinal deflections above the right-hand legs. Electrical resistance strain gauges were used to record the strains induced in various members of the gantry by the test loads, and the leads from the gauges to the recording apparatus can be seen in the foreground.

The particular form of gantry tested was an anchor structure intended to span the normal double track, for which the standard overhead equipment is a duplicated system of compound catenaries, each comprising a main line of 37 strands of 0·104-in. diameter copper wire, an auxiliary line of 19 strands of 0·112-in. diameter copper wire, the latter being used to support the solid grooved cadmium-copper contact wire which has an area of 0·3 sq. in. The gantry was designed to carry the out-of-balance loads of the overhead cables, together with the transverse loads due to a wind blowing at 50 m.p.h. acting on the gantry itself and on the cables, each of which was considered to be covered by a $\frac{3}{8}$-in. thickness of ice. These loads were estimated to be equivalent to pulls of 5,270 lb. in the main catenary, 4,650 lb. in the contact wire and 2,557 lb. in the auxiliary catenary, together with a side load to represent the thrust of the wind against both the gantry and the cables.

The A-frames, which form the legs of the gantry, have to take both the direct compression and tension produced by the longitudinal loads, the compression due to the dead weight and the bending caused by the possible wind load. The main members of each frame were two tubes $6\frac{5}{8}$ in. in diameter by 5 s.w.g.; the tubes were at 15-in. centres at the top, splaying out to 6-ft. 6-in. centres at the base, and the A-frame was 18 ft. 6 in. high to the underside of the bridge girder. At the top, the two tubes were welded to a common flange plate which formed a seating for the bridge girder, and the connection was made by eight $1\frac{1}{4}$-in. diameter bolts. At the foot, each tube was fitted with a welded base which was fixed to the concrete foundation by four holding-down bolts. The intermediate bracing of the A-frames was cut from $1\frac{1}{16}$-in. diameter tube, 8-s.w.g. thick, which was welded to the principals. The bridge girder consisted of two tubes of $3\frac{1}{2}$-in. diameter, 5 s.w.g. thick, forming the upper boom, and two tubes of 4-in. diameter by 5 s.w.g. forming the lower boom, all welded together with intermediate diagonal bracing of tubes of $1\frac{11}{16}$-in. diameter with 5-s.w.g. walls; the four end posts were cut from $4\frac{1}{2}$-in. diameter tubes with $\frac{1}{4}$-in. walls, and each was fitted with suitable foot plates for bolting to the A-frames below. The upper and lower booms, with the end posts and bracing, formed a rigid box girder, 1 ft. 3 in. wide by 6 ft. 6 in. deep, the depth being dictated by the vertical distance that is required between the main catenary and the contact wire.

During the tests, the loads were first increased by equal increments until they reached 1·5 times the estimated working loads, when all the loads were released and note made of the permanent set in the structure; this amounted to $1\frac{3}{4}$ in. at the top of the A-frames in a transverse direction, but nothing longitudinally. The loads were then re-applied up to 2·5 times the working load, without the gantry failing. An additional load of 2,400 lb., representing a terminated earth wire, was then applied to one mast, and the gantry similarly withstood 2·5 times this load without failure. All the longitudinal loads were then increased until the bridge girder buckled at the points of load application. There were no failures of the welds. This is worthy of note, for the use of all-welded tubular structures involving welds in tension is a new feature in this type of work in the United Kingdom.

The weight of the prototype gantry was about 1·7 tons, compared with the 2·95 tons required for the normal lattice structure. The price of a ton of welded tubes is higher than that for riveted rolled-steel sections but, taken in conjunction with the saving in weight, there is a net saving in cost of between 25 and 30 per cent. It is expected that the saving in cost will be even more marked in the case of the larger gantries which will be required in sidings and station areas where more than two tracks have to be spanned and equipped.

Among the advantages of tubular construction in comparison with more conventional steelwork can be numbered those of a reduced resistance to wind, simplified painting of the round surfaces, and a reduced tendency to collect soot and dirt from steam locomotives, so lengthening the life of the structure and the length of time between successive re-paintings. Arising out of this test, two or three welded tubular-steel gantries are to be erected for trial purposes on the Manchester to Sheffield line.

DOLOMITE FOR PLASTICS PRODUCTION.—Over 80 tons of dolomite, quarried from a hillside above the main road at Duror, North Argyll, have been sent south for experimental work in the manufacture of plastic materials. If the tests prove satisfactory, a new industry may be developed in the area.

ROOF TRUSSES BUILT OF OLD RAILS.—While steel was in short supply last year, the difficulty of reconstructing the roof, formerly of timber, of the London Midland Region running shed at Skipton was overcome by using old bull-head steel rails for the roof trusses. The trusses were built in Warren-girder form, with bolted connections between the rails. The roof covering consists of alternate sloping walls of continuous glazing and asbestos-cement corrugated sheets, the former being fitted in timber bars set on one set of diagonal truss members, and the latter supported by bull-head rail purlins secured to the adjacent set of diagonal truss members. Ventilation is provided by a continuous covered opening at the upper node points of the trusses. The use of old rails for this form of construction is stated to have been developed on the Southern Region.

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* "Economic Aspects of Overhead Equipment for Direct Current Railway Electrification," by O. J. Crompton, M.Eng., M.I.E.E., and G. A. Wallace, B.Sc. (Eng.), A.M.I.E.E. Paper read before the Institution of Electrical Engineers on December 4, 1952.

† *Electrification of Railways*. Report published by the British Transport Commission, 1951. [Price 7*s*. 6*d*.].

DESIGN OF PRECISION GRINDING MACHINES.*

By G. H. Asbridge.

(*Concluded from page* 151.)

Work-Heads and Work-Head Drives.

The methods of work rotation fall into three classes: the dead-centre head, the live head, and the live and dead head. Of these three types, the first is used exclusively for plain cylindrical grinding machines, because, as there is no rotating spindle and so no bearing clearance, more accurate work can be produced. The second type is used for internal work and for external work of a chucking nature. The third type, a combination of the first two, is supplied with universal machines, where it may be desired to carry out internal and external grinding without disturbing the setting of the work. However, irrespective of the type of head, the designer must ensure that the spindle or face-plate will revolve with constant velocity and freedom from vibration.

The design of any work-head is largely dictated by the size of the machine and the speed range required for the work rotation. For instance, a work-head for a 10-in. plain grinding machine, giving a range of speeds of from 20 to 300 r.p.m., can be satisfactorily driven using a variable-speed motor and a single layshaft, the drive from motor to layshaft generally having a two-step pulley, so that the motor speed may be increased on the lower ranges, thus increasing the torque available on the work. The final drive can be by endless belt or chain. Up to recent years belt drive has been most common on this size of machine, but chain drive is equally satisfactory and is more lasting. This design of work-head is simple to manufacture, very reliable, has few moving parts, and has given many years of trouble-free service. One is shown in Fig. 3 on page 149 *ante*.

On larger machines, where work speeds of from 5 to 150 r.p.m. may be required, it is usual to interpose a gearbox between the initial drive from the motor and the final drive to the work. While a gearbox in close proximity to the final drive can be a potential source of chatter, care taken in the design stage, by the use of short stiff shafts amply supported, and a gearbox stiff enough in itself to resist any deformation which may affect the centre distances, coupled with care in manufacture to ensure that gear centres are correct and that the gears have their teeth accurately ground or shaved and concentric with the bore, can eliminate much of the danger. The final drives on all heavy machines are exclusively by chain, either inverted-tooth or roller; these two types of chain are used approximately equally by machine makers, and it is difficult to say which is superior. A head with this type of final drive is shown in Fig. 7, herewith.

The use, however, on certain heavy machines where there are no space restrictions, of work-heads which are entirely belt-driven must not be overlooked. These would appear to have all the advantages, but, in fact, this is not so. The amount of reduction necessary on such machines means the use of several layshafts, each of which must have its own adjustment so that belt tension can be maintained; at each successive reduction the number of belts increases, so that by the time the final drive is reached the number of belts may be any number between 16 and 22, which, on a dead-centre head, may necessitate a large overhang of the spindle. Also, the difficulty of obtaining sets of belts, matched so that each will take its share of the load, is not easy to overcome; the matter of easy belt replacement must also be taken into consideration.

The previous remarks apply equally to live-spindle heads, but these provide the designer with the added problem of the type of bearing he should use. As the choice of bearings is limited to rolling bearings or plain bearings, the use of one or the other must be decided from experience, the quality of the desired results, and the nature of the duty of the spindle. Naturally, there is a considerable amount of overlapping, both rolling and plain bearings being used for similar work; but for certain classes of work there is unanimity among the various manufacturers that on all grinders except large heavy machines, rolling bearings are used which, in a pre-loaded condition, give very satisfactory service. On crankshaft-grinding machines, however, which have two live heads, plain bearings are used almost exclusively, though rolling bearings have been tried and found wanting, inasmuch as the finish produced with plain bearings is better than that which can be obtained with rolling bearings, for the reason that plain bearings control the spindle over a longer length and prevent any tendency for it to bend. In general, it may be said that where loads are heavy or where the quality of roundness and finish is high, plain bearings are used, but for high speed and light duty, rolling bearings are satisfactory.

So far, remarks have been confined to consideration of the problems which face the designer in the various detail components of all grinding machines; worthy of consideration, however, are various features of design that affect groups or classes of machines which have to be made suitable for specific purposes. These are not special machines which have been built singly, but those which have been built in large quantities.

Universal machines.—The universal machine, as its name implies, must be as flexible as possible in operation. With this object in view the designer must provide three main features which are not found together on any other type of machine: live-centre and dead-centre work-head spindle, internal and external grinding spindle (of the type shown in Fig. 8, on this page), and double-swivel base to wheel-head. The first, as already mentioned, allows the operator to hold work between centres or in a chuck.

The provision of internal and external wheel spindles is a necessity when work which may require both operations has to be done at one setting. The real problem facing the designer here is to be able to effect the changeover from one spindle to the other as quickly and easily as possible. This has been tackled in several ways. First, by bolting the internal spindle bracket on to the front of the main spindle—a method which is slow and cumbersome; secondly, by mounting the two spindles at opposite ends of a swivel slide. The disadvantage with this arrangement is that if a face has to be ground, the spindle in use has to be brought into a position such that its axis is parallel to the body ways—an operation which involves a certain amount of trial and error even should vernier adjustment be provided. Thirdly, the best method—the one adopted by most manufacturers—is for the internal spindle to be carried on a pivoted bracket which allows it to be swung down quickly into position when required; this does not necessitate disturbing the main wheel spindle in any way, and also each spindle can be fitted with its own motor drive.

The third feature, the double-swivel base, is not found on all makes of universal machine, but can

* Paper presented at a meeting of the Institution of Mechanical Engineers, in London, on Friday, January 23, 1953. Abridged.

DESIGN OF PRECISION GRINDING MACHINES.

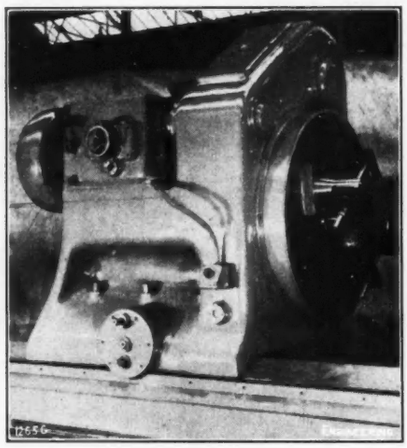


Fig. 7. Work Head for 50-In. Plain Grinder.

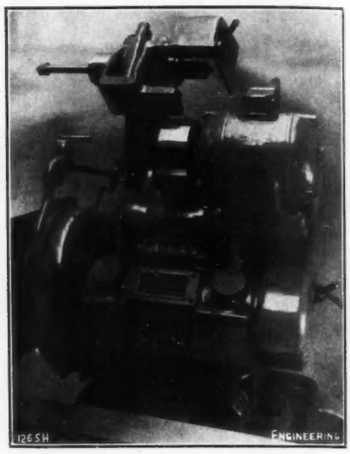


Fig. 8. Universal Wheel-Head with Spindles for Internal and External Grinding.

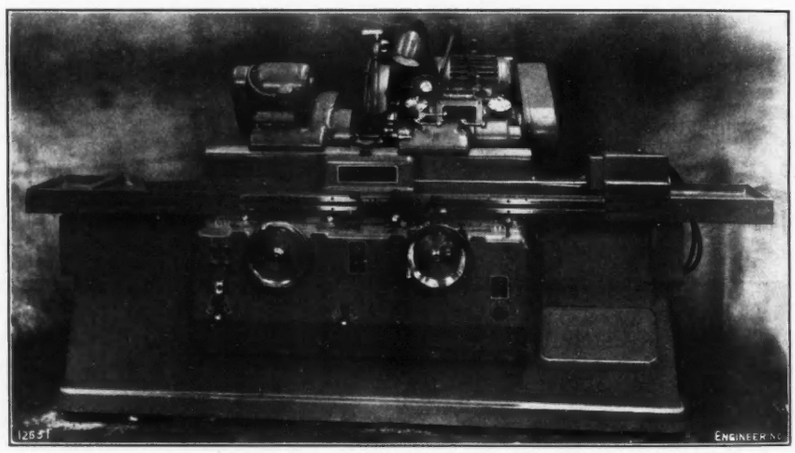


Fig. 9. Automatic Plain Grinder with Tilting-Table Feed.

DESIGN OF PRECISION GRINDING MACHINES.

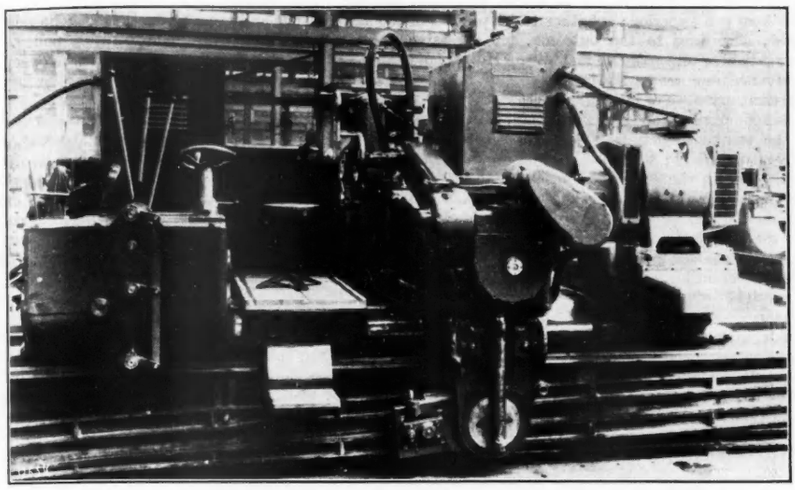


FIG. 10. CAMBERING MECHANISM, USING STRAIGHT BAR.

be a very useful adjunct if work is being ground to very fine limits, as it allows the feed slide to be set at an angle, and the wheel spindle to be set square with the table, thus providing a very fine feed. The wheel spindle can, if necessary, be fed in at an angle or can be used to give a slight longitudinal traverse to the wheel—a feature which, perhaps, is not often called for but can be very useful, besides providing the flexibility necessary in a universal machine.

MACHINES ARRANGED FOR AUTOMATIC OPERATION.

Although the standard plain grinding machine is capable of high rates of production to limits of 0·00025 in. to 0·0005 in. if skilfully handled, the growth of quantity production plus the decline in the quality of operators has produced a demand for machines capable of sizing automatically, thus ensuring the interchangeability of parts and enabling totally unskilled labour to be used to operate them.

The problem of building an automatic sizing machine can be approached in two ways: first, by arranging for the wheel-head to slide forward up to a predetermined dead stop, so that when the wheel-head is at the stop the work is the correct size, and when this point is reached a period of dwell is allowed so that the degree of finish may be improved, and a "rounding up" process also takes place as the cut dies away; this period of dwell can be particularly important when the work is of a slender nature; secondly, by the use of a "sizing gauge" of a visible type, attached to the table or wheel-guard of the machine. This type of gauge is dependent on the operator moving the wheel when the size is reached; further development of this type led to the electrical gauge which, when the desired size was reached, automatically retracted the wheel-head. The chief disadvantages of this system are the absence of any dwell period and the fact that the gauge cannot be used to gauge taper work, as in this case the accuracy of sizing will be dependent on the centre depth. It must, however, in fairness to sizing gauges, be admitted that the question of resetting after wheel truing presents less difficulty than with the sliding wheel-head which, after retruing, has to be advanced by an amount equal to that removed from the wheel by the diamond. Generally speaking, of the two solutions the sliding wheel-head is in more common use than the sizing gauge.

Whatever method of sizing is employed, the design must ensure that the machine is flexible, so that it can be easily and speedily changed over from one component to another with a different grinding allowance. If this adjustment is difficult or awkwardly placed, there is a temptation on the part of the operator or setter to leave the machine set at the maximum metal allowance likely to be encountered, which results in a waste of time on components with only a small grinding allowance. This point is particularly important when it is remembered that the actual rate of metal removal has not increased appreciably over the last 20 years. The increase in productivity has been achieved by cutting down waste time during the cycle of the machine. Thus, unless a machine is correctly set, the machine cannot produce to its maximum capacity. With the sliding wheel-head, great care must also be taken in the design to ensure that the method of feeding forward the wheel-head is rigid and free from any spring; also that the sliding ways are efficiently lubricated, otherwise the constant conditions necessary for accurate repetition are not present and the machine will not repeat accurately.

It was with the foregoing conditions in mind that an automatic machine was produced in which grinding was effected by rocking the table that carried the work forward to the wheel, as shown in Fig. 9, opposite. By this method, as the table is mounted on knife edges, sliding surfaces with their attendant disadvantages are eliminated. Also, all controls, such as adjustment for metal removal and rate of feed, are at the front of the machine, immediately to hand, so that the machine is easily set to give its maximum output. The foregoing remarks apply equally well to internal machines.

ROLL-GRINDING MACHINES.

Roll-grinding machines are large, and for external grinding it is necessary for some sections of the industry to produce rolls other than parallel; such rolls may be concave or convex. The designer is therefore required to introduce into his machine some mechanism whereby this camber can be obtained and accurately repeated. The essential quality of the mechanism must be that it is entirely free from lost motion. Should this not be so, the machine will never produce an accurate shape, but will produce a composite one due to the wheel not following the same track on each reciprocation of the roll.

To obtain this camber, the wheel has to be advanced and retracted during the traverse of the roll; this is usually accomplished by giving the wheel-head a rocking motion around a fulcrum built into the wheel-head base. This motion, in the majority of machines, is obtained by a cam connected through to the traverse of the machine, and to ensure the necessary freedom from lost motion the designer is forced to use split gears which, unless carefully constructed and adjusted, give rise to excessive wear.

Another method of obtaining the roll shape is to use a straight bar instead of the cam; if this bar is inclined at an angle and a slipper is used to give rotary motion to a drive—which can be connected to the wheel-head to give a rising and falling motion—then, according to whether the top half or bottom half of the disc is used, the camber will be concave or convex. This method, which is shown in Fig. 10, on this page, has the advantage that lost motion is at a minimum and the degree of camber is obtained by the angular setting of the bar; thus there are no gears to wear or leverages to be adjusted, as in the former method.

It must be remembered that one design is a compromise; in the assembly of a series of mechanisms to form a complete machine it is never possible to have the best arrangement of each part—there must always be some sacrifice of ideals so that the completed machine may represent the best combination.

ALVIS "LEONIDES MAJOR" AIRCRAFT ENGINE.

SOME particulars have been published recently by Alvis, Limited, Coventry, of the new Leonides Major piston engine for aircraft, which is now in an advanced state of construction and is expected to undergo its first tests later this year. The Leonides Major has been designed to meet the need for an engine developing about 50 per cent. more power than the existing 550-h.p. Alvis Leonides engine, which is used in the Percival Provost basic-training aircraft, the twin-engine Percival Prince transport aircraft and its military versions, the Sea Prince and the Pembroke, as well as in the Westland S.51 and Bristol 171 and 173 helicopters. The Alvis Leonides Major is, at present, intended for a development of the Pembroke general-purpose aircraft, which is in production for the Royal Air Force, and to replace the American Pratt and Whitney engine now fitted in the Westland S.55 helicopter. It will, therefore, be produced in two versions, a horizontal-crankshaft engine for conventional propeller-driven aircraft, and a vertical-crankshaft engine for h licopters.

The Alvis Leonides Major, in both forms, is a 14-cylinder supercharged two-row radial engine, developing a maximum power (5-minute rating) of 870 b.h.p. at sea level. The estimated performance of the Leonides Major engine is, briefly, as follows: maximum continuous power rating, 700 h.p. at 7,000 ft., with a specific fuel consumption of 0·65-0·69 pints per b.h.p. per hour and an oil consumption of 6 to 10 pints per hour; maximum weak-mixture power rating, 515 b.h.p. at 11,000 ft., with a specific fuel consumption of 0·525-0·555 pints per b.h.p. per hour. At maximum power (870 b.h.p.) at sea level, the specific fuel consumption is estimated at 0·78-0·82 pints per b.h.p. per hour.

The Leonides Major has overhead poppet valves, operated by push-rods. The supercharger is of the single-stage single-speed centrifugal type, with a speed ratio of 6·5 to 1, and a Hobson low-pressure fuel-injection system is fitted. Accessory drives for an electrical generator and tachometer-generator, an air compressor, a hydraulic pump, and a vacuum pump are provided. The cylinder bore is 4·8 in. and the stroke is 4·41 in. The compression ratio is 6·8 to 1. In the propeller version, the driving reduction-gear ratio is 0·533 to 1. The overall diameter of the engine is 39 in.—less than that of the existing Leonides engine, which is 41½ in. Thus, the more powerful engine installation will be more compact and, in the case of propeller-driven aircraft, will offer less drag.

PLASTIC TELEPHONE CABLES IN DENMARK.—What are stated to be the first carrier-frequency land communication cables to be insulated with Telecothene were formally handed over to Mr. G. Irming, managing director of the Kjobenhavns Telefon Aktieselskab, on Wednesday, January 28. These two cables, which were manufactured by the Telegraph Construction and Maintenance Co. Ltd., Greenwich, London, S.E.10, are each about 20 miles long and are laid between Copenhagen and Roskilde. They form part of the first stage of a new telephone network, which is being installed on the Island of Sjealland, and each contains 48 conductors forming over 1,000 circuits. The insulation consists of a tubular Telecothene sheath which, being unaffected by water, requires no lead covering. Their light weight has facilitated installation.

DEVELOPMENT OF THE ENGINEER IN PRACTICE.*

By R. A. RIDDLES, C.B.E., M.I.Mech.E.

THE President in his address drew attention to the gap which must exist between the completion of academic and practical training and the emergence of the practical engineer able to take responsibility for organisation and administration, whether of a design office, workshop, or a whole industry. I thought it might interest you to-day if I enlarged upon that theme, and, taking a national industry as an example, talk about some of the things you can only learn under the general heading of experience.

Steam, electric, Diesel and gas-turbine propulsion are available for railways to-day. Selection between them is a matter where engineers must guide management, though the decision rests more on economic than on technical grounds. The situation is confused by the rival claims not only of those who have specialised professional knowledge, but also by those who have equipment to sell, or are interested in the use or limitation of use of particular fuels, by those who are interested as traders or passengers, or by those who are just interested.

Table I shows the results from recent trials with particular locomotives working broadly comparable trains and routes. While the relationship will, of course, vary with the kind of duty, the figures do show the need for care in relying too much on thermal-efficiency relationships.

If the choice is based on overall costs, as it should be, then an element of prophesy enters which is far removed from the exactitude to which engineers and accountants are trained. If an electrification is at issue, changes in price levels and in traffic volume during the preparation and conversion period can make the difference between profit and loss, while the modifications to train schedules for greater frequency and faster speeds may or may not attract sufficient traffic to cover costs. If "Dieselisation" is under consideration, ability to operate the power units with one man is usually a decisive feature, but where the unions insist on two men in the cab, there is a considerable speculative element in forecasting the kind of intensive duties which might liquidate high capital costs.

STANDARDISATION OF LOCOMOTIVES.

Standardisation is not, of course, an invention of the nationalised railways, but is as old as railway history. What are the objects of standardisation? How should standards be selected, and how far should then extend? The objectives, in order of importance, are: to render manufacture and repair more economical by reduction in the number of types, particularly of components; to build only locomotives which are capable of running anywhere in Great Britain; and to incorporate the best technical practices. As examples of the effect of standardisation, there are over 60 important fittings and components which are either common to the whole range of British Railways standard locomotives, or of which a limited range of sizes of the same basic design equally apply. The need for locomotives to run anywhere is emphasised if you think of how steam locomotives must be redistributed after the introduction of alternative forms of traction.

The final question is perhaps the most important of all: How far should standardisation extend? Here is scope for the highest exercise of engineering acumen, to retain the objects and advantages which are obvious while at the same time keeping the standards fluid enough to incorporate new ideas and techniques from all sources as they become available, yet without bedevilling the production departments by constant change of pattern.

INNOVATION AND DEVELOPMENT.

Continuously facing those with responsibility for taking decisions is the choice between developing the existing and well-tried or launching out into something new. The problem is to judge what will be of lasting value without losing more money than we can afford on what may be different but is not in the long run superior; whether to be praised or blamed, according to the outcome, for excessive conservatism or unwarranted rashness. How should we advance our art? By invention, by personal preference, by always concentrating on the latest, by change only for the sake of change? That way lies the stroke of genius which may change the whole future trend; but that way also lies the last dismal scene in the scrap-yard when the acetylene flame cuts through the inert body on which too much money and hope has been lost. Or is choice to be made by painstaking record and comparison, by experiments and trials and continuous assessment of costs? Solid but slow and conservative progress will result.

Of course, our progress is always a mixture of both methods, and each as he becomes responsible must choose the proportions. Taking the broadest view of rail traction, in the past hundred years the outstandingly successful innovations of widest application can almost be counted on the fingers of the hands, while the failures have been countless. Of any or all of these latter it was said at the time that if only there had been more perseverence, success lay just round the corner; or, if their failure was economic, if only ten or a hundred had been tried instead of one, all would have been different. While we should and do leave nothing untried which can possibly lead to improvement, there is a limit to the scale of the trial imposed by the resources available to any commercial concern.

Necessarily slow, this process sometimes gives rise to great impatience on the part of the non-technical mind, which suspects that the engineer is too engrossed in the sheer interest of his work to brave the discomforts of the unknown. This impatience may also assail the young engineer entering industry. In his first lowly position, his mind seething with bright ideas, he may find maddening the preoccupation with the commonplace which he finds around him. The hardest lesson, but very essential, is to learn to grapple with the humdrum, for it is only against the background of daily use and experience that the worth of innovation can be fully established.

PRODUCTION METHODS FOR REPAIRS.

Volumes have been written on production methods for new construction, but 61*l.* million is spent annually on rolling-stock repairs, twice as much as on new building. We are continually seeking, therefore, to apply up-to-date production principles to repairs. A considerable degree of organisation and control is brought to bear before the rolling stock reaches the workshop, because without some means of forecasting arrivals and relating their numbers to works capacity chaos could result. Development in the past five years has aimed at extending progressive systems of repair to all workshops, to reduce the time taken without sacrifice of quality. Independent examination both of work required and work finished, establishment of limits of wear, stocking of replacement parts in stepped sizes, and working to a timetable both for repair of details and reassembly of the whole locomotive are some of the methods used These practices have enabled the net operating stock on British Railways of 18,729 locomotives to be kept in first-class repair with no more than 960 engines, or 5·13 per cent., under or awaiting repair. As a means of analysing financial results, a system of individual costing of selected locomotives amounting to 10 per cent. of the total stock has been introduced. This permits comparisons of expenditure, so that design and repair practices can be related to cost and mileage as a guide to future policy. It also serves as an index of comparative repair efficiency in the different works, always allowing for unavoidable variations in local conditions.

You can realise how little of all this essentially engineering work is to be found in text-books, and there is no other way of learning this side of the work than by doing. That it can be very rewarding is instanced by the fact that in three years only, notwithstanding rises in wages and material costs, it has been possible to reduce the cost of engine repairs by just over one penny per mile run, which represents two million pounds in the year.

MATERIALS.

The President in his address made the point that a deep knowledge of his material is essential to the engineer, and this is especially true of the railway engineer, who is for ever balancing considerations of safety, strength, weight, cost, resistance to corrosion, and availability on the market. Railways must organise perfect safety on over a million units running on the line, any one of which could precipitate a serious accident as a result of a failure. One way of ensuring safety is to set up railway materials specifications which call for rather more control than is provided in B.S. specifications, particularly in laying down chemical analysis. An extensive materials-testing organisation is maintained, and in conjunction with the Research Department inquests are held into all important material failed in service so as to ascertain the feature which was at fault.

Rolling stock, especially wagons, have a very rough time, and the impacts arising from shunting, and the need to mitigate as far as possible the effects of collision, call for selection of the size of all the main members considerably in excess of that dictated by ordinary design considerations. Loads which are known can be designed for accurately, but many of the impact loads met in service cannot be measured. Then again, corrosion is always at work; bigger sections have to be used so that sufficient strength still remains.

These considerations tend to put up the weight, but economy in traction cost demands weight reduction. High-tensile steels allow this without assisting the problem of corrosion. Aluminium alloys are expensive, and stainless steel even more so. There is a definite limit on the amount we can spend on weight reduction to break even on lower traction costs. For example, a ton of weight saved on a passenger vehicle will reduce fuel cost by an amount per annum which, when capitalised, will allow only 200*l.* more to be spent on the total cost of the coach. Another aspect which must be borne in mind is repairs at out-stations. A failure of some simple item of running gear may occur anywhere in the country and the nearest depot may be a distant outpost with few facilities and little equipment. High-tensile steel does not lend itself, in many grades, to simple welding and straightening, and any savings in weight will soon cease to pay if heat-treatment plants have to be set up in lineside repair depots.

PASSENGER ACCOMMODATION.

In the design, construction and repair of coaching stock, the element of safety rises to paramount

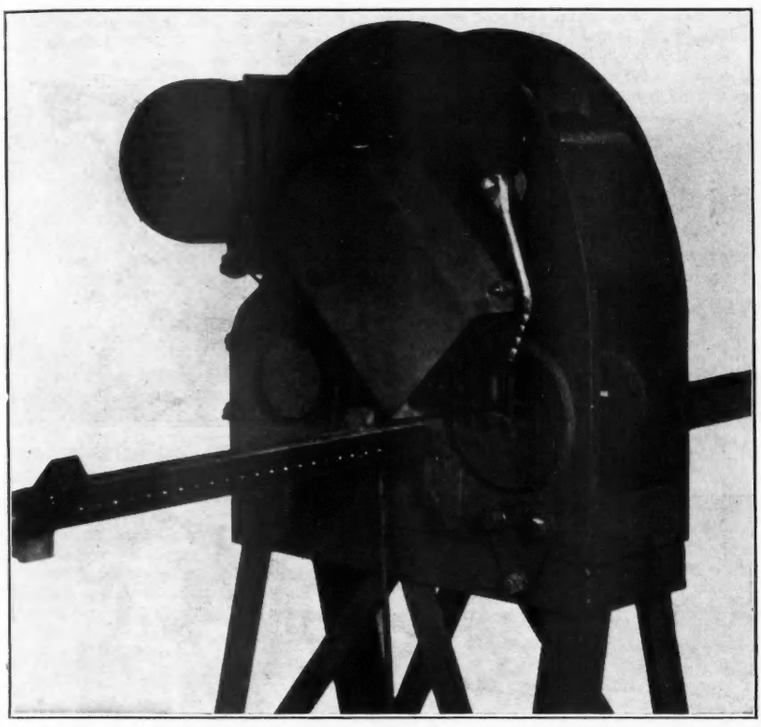
TABLE I.—FUELS COST OF DIFFERENT FORMS OF RAILWAY MOTIVE POWER.

—	—	Average Train Load, Tons.	Unit Cost of Power or Fuel as delivered to Locomotive.	Thermal Efficiency, Fuel to Drawbar, Per cent.	Fuel Cost.	
					Pence per Mile.	Pence per d.b.h.p. hour.
Electric ..	S.R. Locomotive No. 20,003, Victoria-Newhaven	436	1·06*d.* per kW-hr. at 3rd rail	11·5	20·8	1·28
Diesel-electric ..	S.R. Locomotive No. 10,202, Waterloo-Exeter	350	1·51*d.* per lb. ..	18·8	12·8	1·05
Gas-turbine ..	W.R. Locomot ve No. 18,000, Paddington-Plymouth	360	1·10*d.* per lb. ..	6·6	27·7	2·27
Steam	W.R. "Castle" Class, Paddington-Plymouth	360	0·37*d.* per lb. ..	5·5	12·6	1·18

* Annual Lecture to the Graduates' Section, London, of the Institution of Mechanical Engineers, delivered on January 24. Abridged.

BAR AND ANGLE SHEARING MACHINE.

ARROW MACHINE TOOLS (HALIFAX), LTD., SOWERBY BRIDGE.



importance. There are three special hazards, the effects of which must be reduced to the absolute minimum, namely, collision or derailment, fire, and accidents with doors.

Nobody has measured the impact forces which can be applied to a carriage body in a high-speed collision, but recent design has increased the end-loading which the underframe will withstand without permanent deflection from 100 tons to 200 tons. The main body members are now welded to the underframe so that the body cannot be swept clean off the frame by telescoping, and the Buckeye automatic centre coupler has been adopted so that a derailed train shall be held together more positively. Fire on a train is a rare hazard, but one whose effects must be guarded against in every possible way, and besides the more obvious provision of fire extinguishers, the materials used at floor level, and more particularly under the seats, require close study, as do ready means of exit in the form of external doors.

In the realm of comfort, there are few absolute standards. The riding of a carriage with almost any design of bogie can be kept tolerable if the amount of wear is held to sufficiently fine limits, but the frequent shopping which would result would be very expensive. Similarly, a double-bolster bogie, as used on some British main-line corridor coaches, gives a better ride than the single bolster, but is heavier and costs more to build and maintain. Or, turning to another aspect, compartments could be larger and contain individual armchairs, if we could afford to haul two tons of material for each passenger seat instead of about ¾ ton as at present.

WEIGHT OF NUMBERS.

In such a unit as the railway wagon the engineer meets in full force the problem of sheer numbers. There are 1,146,000 of them to-day. Placed end to end they would reach from here to Karachi, a distance of 4,400 miles. There were 480 varieties in 1948, and one aspect of standardisation is proceeding on the lines of choosing only one out of the four varieties of each type which existed in the four former companies and applying to it a range of standard parts. Even so, having regard to the different requirements such as coal, iron ore, potatoes, cattle, etc., not less than 120 varieties will have to be retained to deal with all the traffic, and also to meet the need to vary constructional methods having regard to availability of materials and workshop equipment. Apart from this, developing traffic needs are always demanding new design development. A recent study of the size of mineral wagons to give the best obtainable operating efficiency has called for production of the largest wagon on four wheels which the civil engineer will accept, and the 24½-ton wagon is the result. Although wagon design cannot be called high-class work and does not make heavy demands so far as academic attainments are concerned, the 17½*l.* million spent on renewals and the 25*l.* million spent on maintenance each year calls for economical design of the highest order, and places considerable responsibility on the engineers. From this point of view, wagon design is far from simple.

MONEY.

I will conclude my lecture by dwelling once more on the financial aspect, which in every commercial concern is of vital importance. You may have learned in your theoretical and practical training to be good engineers, but you cannot be useful to practical engineering without a highly-developed money sense. In railways, the cost of every proposal must be estimated and its effect on running costs established. The steady rise in labour and materials costs makes it essential to reduce the other costs. This is not the same as a requirement always to produce the cheapest in first cost. For any rolling stock unit, or component, the cheapest is that whose first cost plus maintenance throughout its life is the least.

It follows, therefore, that the accountant must dog the steps of the engineer throughout his career, often a most irksome companion when he causes the first fine rapture of creative thought to shrink to the miserable level of what the organisation can afford. But you might as well get used to the idea first as last for there is no magic by which any of you can alone be emancipated from the burden of paying your way. Accountants are seldom trained engineers, so that they can only assemble into proper financial form the facts and estimates provided by engineers, and the art of working with accountants, of preparing estimates, of assessing savings, of making intelligent prophesy as to the ultimate financial effect of alternative lines of policy are other aspects of your future work.

Unless you are lucky, considerable periods of drudgery are inevitable, but I can think of no place you may occupy in the industry where you cannot learn from what is going on around you. In presenting these views I do not for a moment under-rate the importance of technical training. But even academic brilliance is not enough in such an undertaking as I have described; clear thought, logical deduction, common sense, and the ability to work with and through others are equally essential. The compensations of such self-discipline are very great. To attain an administrative post ill equipped in the qualities I have outlined is a perpetual anxiety and misery, but to be master of the job, confident in what you undertake, will not only bring you high satisfaction, but will galvanise your staff and produce a working team in the real sense of the term. The thrill of achievement, of seeing a long-developed project at last in actual being, and giving results, is one of the purest of joys, which more than compensates for the fact that engineering is not often the most remunerative of callings.

BAR AND ANGLE SHEARING MACHINE.

THE shearing machine shown in the accompanying illustration is designed to crop angle iron up to 2 in. by 2 in. by ¼ in., at high rates of production, and is made by Arrow Machine Tools (Halifax), Limited, Winton Works, Sowerby Bridge, Yorkshire. By use of special blades and blade holders, it can also be adapted for other sections of material.

The body of the machine is of mild-steel welded construction, and is designed to give easy access to the operating parts for maintenance. A V-belt drive from an electric motor is used to drive the machine. All gears are of high-tensile steel and are mounted on splined shafts. Two of these shafts are carried in plain bearings, while the third shaft, which carries the flywheel, is mounted in ball bearings. Splash lubrication is from the flywheel, which runs partly immersed in the oil sump and throws oil into gulleys from which it is fed to other parts of the machine; a dipstick is provided for checking the sump oil level. The clutch is a multi-point type and is operated by a hand lever.

The cutting slide has no crosshead pin, but movement between the eccentric and the slide proper is allowed by means of a phosphor-bronze plate, which takes the thrust from the eccentric for the stroke of the cutting slide, and also allows the necessary sideways movement of the eccentric. The eccentric runs in a phosphor-bronze bush. The Cupo Zanogen-steel cutting blades, a product of Messrs. J. Fearnehough and Son, Limited, Garden-street, Sheffield, 1, are mounted rigidly but are easy to remove for sharpening. Compensation for wear of the cutting blades is made by increasing the thickness of the phosphor-bronze sliding plate mounted on the eccentric, and for this purpose shims of $\frac{1}{16}$ in. and sliding plates of $\frac{3}{8}$ in., $\frac{1}{2}$ in. and $\frac{5}{8}$ in. are provided. A reaction stop that can be adjusted by an ordinary spanner, to suit the thickness of material being handled, is fitted between the two walls of the body, and two adjustable and hardened guide plates are provided in the wall opposite the cutting blades to ensure square cutting.

A roller conveyor is attached to one side of the machine, and a stop bar, with a stop located by a spring-loaded pin, to the other. The stop also has screw-operated adjustment to provide fine settings and to cover the distance between locating-pin holes on the bar. A foot-controlled release is attached to the stop bar to move it sufficiently far to permit the quick removal of any cut length of bar that might jam between the stop and the machine after shearing.

CURRENT CHOPPING IN HIGH-VOLTAGE CIRCUIT-BREAKERS.*

By A. F. B. Young.

The arc in an alternating-current circuit-breaker has finite conductivity at current zero. At this point, too, the power input from the source is very small, the loss from the air is still fairly large and the arc conductivity is therefore dropping rapidly. If the conductivity is reduced sufficiently during the period near current zero, the power that can be fed into the arc after current zero may be so limited that the losses cannot be supplied and the arc is extinguished. Such an extinction by cooling is usually termed thermal clearance, and is considered by the author to be the basic process in all circuit-breakers, although it is not necessarily the only requirement for successful clearance. In both air-blast and oil circuit-breakers, extinction is very rapid and usually the system capacitance shunting the arc allows it to occur before the re-striking voltage begins to rise from zero. A second requirement for clearance is therefore that the circuit-breaker gap must withstand the re-striking voltage. In both types of circuit-breaker, too, the rapid build-up of arc resistance tends to cause premature reduction of the arc current to zero. This is the basic form of current chopping. In practice, oscillations of the arc current, caused by sudden changes in the arc resistance, cause the current to pass through zero even earlier.

The maximum current that a circuit-breaker will chop is substantially independent of the root-mean-square arc current, but is affected by the capacitance shunting the circuit-breaker gap and by the maximum rate of rise of re-striking voltage that the gap will withstand. When a circuit-breaker interrupts a small highly-inductive current, current chopping results in transient voltages across the inductance. These voltages may have large prospective values and may be dangerous to equipment, but are limited by the circuit-breaker. They are determined by the inductance controlling the current, the effective capacitance shunting the inductances, and the losses in the inductance. The principal losses are caused by hysteresis and eddy currents. The circuit-breaker limits the prospective voltages by limiting the current that can be chopped and by re-striking the arc in the contact gap. The effectiveness of the limiting action of the contact gap is controlled largely by the inherent damping of the transformer or shunt-reactor which is being controlled. If the root-mean-square current which is being interrupted is small, as for instance, the magnetising current of a transformer, the limiting action is more effective in the type of circuit-breaker with a gradually-increasing contact gap (i.e., most oil-break circuit-breakers) than in one with a fixed contact gap (i.e., many air-blast circuit-breakers). The relationship between the transient voltage due to current chopping and the root-mean-square current interrupted can usually be considered in two parts: one in which the voltage is controlled by the limiting action of the contact gap, and the other (for larger root-mean-square currents) in which the voltage is controlled by the maximum current that the circuit-breaker will chop. The maximum current usually occurs with a root-mean-square current corresponding to a shunt reactor.

Among the conclusions reached with regard to the practical implications of current chopping and the generation and limitation of the circuit voltages, it may be pointed out that the switching of transformer magnetising current by oil circuit-breakers produces small voltages owing to the small gap at which clearance can take place. Air-blast circuit-breakers with a fixed gap tend to produce larger voltages, but these can be controlled by the circuit-breaker design. The switching of shunt reactors produces higher voltages than the switching of transformers in both air-blast and oil circuit-breakers. The voltage produced by the switching of shunt reactors should, if required, be reduced by damping the reactor rather than by fitting resistors to all the circuit-breakers, irrespective of their duty. A simple device is a low-voltage resistor which is connected across a tapping on the reactor during switching by an auxiliary switch that closes when the circuit-breaker opens.

The use of switching resistors of the kind suitable for controlling the rate of rise of re-striking voltage has little effect on the transient voltages when the current is chopped by air-blast circuit-breakers. It can, however, produce a significant reduction when the larger root-mean-square currents are chopped by oil circuit-breakers. The ability of circuit-breakers to interrupt small inductive currents should, where possible, be tested in a three-phase circuit, care being taken to represent the capacitance and losses of the circuit adequately. The voltages produced by a circuit-breaker when switching small inductive currents are predictable, if the circuit constants and the gap breakdown voltage characteristic are known. The voltages produced by current chopping are determined by the characteristics of both the circuit-breaker and the transformer or reactor.

* Paper read before the Supply Section of the Institution of Electrical Engineers on Wednesday, January 28. Abridged.

"Creep Properties of Steels for Power Plants—I." Erratum.—In a footnote to the title of the article by Dr. A. E. Johnson and Mr. N. E. Frost, which appeared on pages 25 and 58, *ante*, it was stated to be a "Communication from the National Physical Laboratory," which was incorrect. The work which was the subject of the article having been carried out at East Kilbride, the report should have been described as a "Communication from the Mechanical Engineering Research Laboratory," the Director of which approved it for publication.

MECHANICAL WEED-SPRAYING EQUIPMENT.

PEST CONTROL, LIMITED, CAMBRIDGE.

Fig. 1. Typical Low-Volume Sprayer.

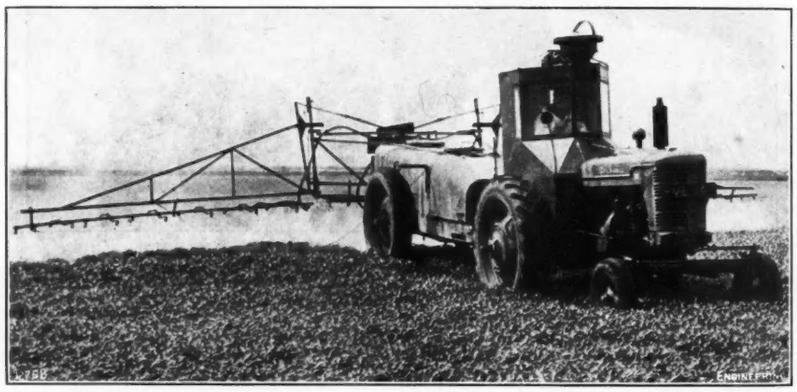


Fig. 2. 500-Gallon High-Pressure Sprayer.

MECHANICAL WEED-SPRAYING EQUIPMENT.

A demonstration of the sprayers they have designed for the control of pests and weeds with a view to obtaining higher yields per acre was given by Pest Control, Limited, at Bourn, Cambridge, on Tuesday, January 27. This demonstration was a prelude to a tour during which the smaller models will be exhibited in different parts of the country, to give farmers an opportunity of assessing their capabilities for different classes of work.

A typical low-volume sprayer is the Weedmaster Mark III, which is illustrated in Fig. 1. A feature of this machine is that the operator has complete control of the spray from the driver's seat. This is important, since the capacity of the tank is only a few gallons and it is therefore difficult to avoid over-dosage. Other features are that blocking of the nozzles is prevented by three stages of filtration and that the spray bars are fitted with independently-operated valves so that narrow strips can be covered without overlapping. The spray bars are also hinged horizontally, so that they do not bend or break when meeting an obstruction. The sprayer can either be mounted on the drawbar or fitted to the linkage of a number of well-known tractors, as shown in the illustration. The pump is integral with the machine and is driven by the tractor through a universal coupling.

Another machine, which occupies an intermediate position between the low-volume and high-volume sprayers, is the Fieldmaster. This consists of a 100-gallon steel tank of all-welded construction, which can be rapidly filled with liquid by an injector and the internal surfaces of which are treated against corrosion, so that any wettable

powders or liquid, except sulphuric acid, can be carried. The weed killer is poured into the tank through a large basket-type strainer and is delivered by an "Arun" pump with a capacity of 15 gallons per minute at a pressure between 40 and 200 lb. per square inch. The suction of this pump is provided with a strainer, and all parts which come into contact with chemicals are made of corrosion-resistant materials, the cylinders being vitreous-enamel lined. The pump delivers the liquid to 16 spray nozzles through a third filter, and in order to deal with solutions containing materials which readily settle out, a high-speed mechanical agitator, driven from the tractor, is included in the system. The spray bars, the heights of which are adjustable and which have an extended width of 22 ft. 6 in. giving an effective spraying width of 24 ft., are in three sections and are carried on spring-loaded booms to reduce the risk of damage if an obstruction is encountered. They are also hinged so that they can be stowed vertically for travelling. Two sets of nozzles are provided for high-volume and low-volume work, respectively. The sprayer is mounted on a trolley, the gauge of which can be adjusted between 42 and 60 in., depending on the crop row width, while a drawbar is provided so that it can be attached directly to the tractor.

The high-volume high-pressure sprayers, of which a typical example is illustrated in Fig. 2, are of the same general design as those just described, the main difference being that they are equipped with three-cylinder horizontal-plunger pumps. These pumps are made throughout of non-corrodible materials and have an output of 35 gallons per minute at a pressure of 600 lb. per square inch. The sprayer is equipped with tanks up to a capacity of 500 gallons, the latter being intended for the use of the larger farmers and contractors. Such a machine is capable of treating up to 80 acres per day and can be fitted with a 30-ft. boom assembly for weed and insect control, with potato-spray bars carrying underleaf extensions to cover 11 rows, with semi-automatic fixed spray bars for bush fruits and cordon trees, or with a fully automatic oscillating back for orchard work. It is mounted on pneumatic-tyred wheels, the steel axle of which is in two sections, so that the track width can be adjusted between 42 and 60 in. As will be seen from the illustration, the tractor used for hauling these machines can be equipped with a gas-proof, air-conditioned cab.

TRADE PUBLICATIONS.

Automatic Processing of X-Ray Films.—A leaflet from Nucleonic and Radiological Developments Ltd., 22, Marshgate-lane, London, E.15, describes the automatic processing unit for X-ray films which they have designed for medical and industrial use.

High-Voltage Insulation Tester.—We have received from Aga Standard Ltd., 16 and 17, Devonshire-square, London, E.C.2, a leaflet describing in detail the Isolex high-voltage insulation tester, produced by Dr. Ing. Frank Früngel, Physikalisch-technisches Laboratories, Hamburg, Germany, for which they are agents. The instrument, which is steplessly controllable, is available in 30-kV and 120-kV sizes. A range of accessories for use with either insulation tester includes a voltage-surge device to simulate the surges that may be expected in service; a high-potential measuring bridge for locating line faults; and an air-ignition device.

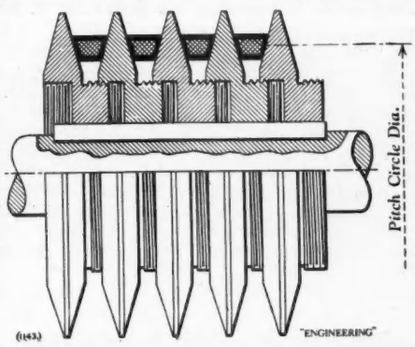
Laboratory Centrifuge.—Sharples Centrifuges, Ltd., Woodchester, Stroud, Gloucestershire, have issued an illustrated leaflet explaining the operating principles of their super-centrifuge, which can be used either for clarifying oil or for separating a mixture of oil and water.

Silicone Rubber.—Engineers and others who are still unfamiliar with the remarkable properties of silicone rubber will find much useful and interesting information in a booklet recently issued by the Dunlop Rubber Co., Ltd. (General Rubber Goods Division), Cambridge-street, Manchester, 1. The physical properties of the material are tabulated and its advantages and limitations in several industrial applications are explained. Perhaps its most important property is that it retains its softness and flexibility over a very wide temperature range, but it is also resistant to oil and certain chemicals and has good electrical properties.

Handwheels and Handles.—We have received from the Ray Engineering Co., Ltd., Southmead, Bristol, a wall chart illustrating the different patterns of moulded plastic handwheels, handles and knobs that they make.

UNIVERSAL V-BELT PULLEY.

A RANGE of V-belt pulley segments, which can be built up to give any desired number of grooves and can be adjusted over a range of pitch-centre diameters, has been introduced in this country by Jac Universal Pulley, Limited, 67, Chandos House, Buckingham-gate, London, S.W.1. A section through a Jac pulley is shown below. It will be seen that each segment has a threaded boss on one side and a threaded socket on the other side, which is screwed to the boss of the adjacent segment. The segments are shaped so that a V-shaped groove is



formed between them when they are screwed together. Thus, multiple-grooved pulleys may be built up by screwing together the appropriate number of segments. After the segments are assembled tightly together, bores for the shaft and keyways are cut in them. The pitch-circle diameter can then be reduced in steps of $\frac{1}{4}$ in. by removing the key and unscrewing through a full turn. JAC pulley segments are available in a range of sizes suitable for V-belts of dimensions $\frac{3}{8}$ in. by $\frac{7}{32}$ in. to $\frac{7}{8}$ in. by $\frac{5}{8}$ in., with corresponding maximum pitch-circle diameters of from 2 in. to 10 in.

EXPORTS OF OFFICE EQUIPMENT DURING 1952.

DURING 1952, the British-office equipment industry exported more than 14,000,000*l.* worth of equipment, an increase of 5,250,000*l.* over the total exports in 1950. The shipments of office machinery represented a 354 per cent. increase over those of 1950. It is stated by the Office Appliance and Business Equipment Trades Association that when their machinery section's "known and expanded schemes of expansion have been fully realised, an annual production of 45,000,000*l.* will be possible." A creditable achievement during 1952 was the export of accounting and calculating machinery, which rose from 2,947,447*l.* in 1951 to 3,196,788*l.* in 1952. The 1952 figure represents an increase of 141 per cent. over that of 1950, which itself was a 225 per cent. increase over that of 1948. Typewriter production in the United Kingdom during 1952 was at a rate of 160,000 a year—more than double that of 1949. Of these typewriters, 2,178,185*l.* worth were exported during 1952, less than the 1951 figure, but a 49 per cent. increase over the 1950 exports. Duplicator exports showed an increase in revenue of 40 per cent. over that of 1950. The revenue from safes and cabinets during 1952 was 2,038,172*l.*—an increase of 89 per cent. over that of 1950.

LIGHTING IN CINEMAS.—A joint committee of the Institution of Electrical Engineers and the British Standards Institution have drawn up a draft code on "Safety Lighting and Primary Maintained Lighting in Cinemas," which supplements the statutory regulations made under the Cinematograph Act, 1909. This code indicates how the effectiveness of the lighting is influenced by the architectural proportions and planning of the building, the layout of the seating, the location of the exits, the decorations and the furnishings and the brightness of the screen or stage. It has been circulated to interested persons and bodies, from whom comments are invited by Monday, February 23. Copies can be obtained from the British Standards Instituion, Sales Branch, 24, Victoria-street, London, S.W.1, at a price of 2*s.*

NOTES ON NEW BOOKS.

Surveying and Field Work.

By JAMES WILLIAMSON, M.I.C.E. Third edition. Constable and Company, 10-12, Orange-street, London, W.C.2. [Price 40*s.* net.]

THIS book was first published in 1915 and a second edition appeared in 1938, but, as the unbound copies of the latter edition, as well as all the plates, were destroyed by enemy action, the text of the present volume has been reproduced by photographic means. This prevented any general revision of the whole, but some sections have been removed and replaced by material required by the newer applications of surveying which have come into use in the 14 years' interval. A new chapter has been prepared on hydrographic and hydro-electric surveying, a field previously treated in works on hydraulics, but necessarily here regarded from the point of view of the land surveyor. Detailed directions are given for the taking of soundings in lakes and in tidal waters, and for measuring the integrated discharges over the whole of the vertical sections of such streams, the advice and examples given being based on actual surveys carried out by the author. Attention is also paid to echo-sounding, a development of recent years, which discloses a remarkable amount of detail of submarine features. The book is directed to the student and to the practical surveyor. On a first examination, the reader may be a little surprised by a scrupulous attention to the details of, apparently, the most trivial points, such as the correct holding of an arrow in simple chaining: but it is not long before the purpose becomes clear—it is that no mistake or oversight which a beginner might make through ignorance or carelessness is not foreseen and dealt with in full. When it is seen that the method is applied uniformly throughout the book, its value becomes apparent. Among the many excellent books on surveying, this may justly claim its place. The author has refrained from discussing aerial surveying, though a general reference to its uses might not have been out of place.

Practical Mathematics, Vol. II.

By LOUIS TOFT, M.Sc., and A. D. D. MCKAY, M.A. Third revised and enlarged edition. Sir Isaac Pitman and Sons, Limited, Parker-street, Kingsway, London, W.C.2. [Price 30*s.* net.]

IN the third edition of this well-known college text-book, published 21 years after the appearance of the first edition, the authors have divided the book into two volumes. Vol. II is concerned with the subject matter of Part II of the syllabus in mathematics for the University of London degree in engineering. To cover this syllabus—and to give an adequate mathematical background for a ready understanding of engineering subjects to Part II degree standard—new chapters have been added and existing ones enlarged. The new chapters relate to the complex variable, vector and scaler products and partial differential equations, together with a chapter on nomograms. Among the enlarged chapters are those on ordinary differential equations and applied mathematics. As in the earlier editions, the text is liberally supported by worked examples, and each chapter is concluded with a selection of 50 ore more examination questions, mainly drawn from recent degree papers. Of an earlier edition, it was noted in ENGINEERING that "the clear treatment affords evidence of the extensive teaching experience of the authors"; this latest edition sustains that earlier opinion.

Applied Heat for Engineers.

By DR. J.-B. O. SNEEDEN. Second edition. Blackie and Son, Limited, 17, Stanhope-street, Glasgow, C.4. [Price 20*s.* net.]

THE scope of this text-book covers the knowledge required by students preparing for Part I of the London University degree in engineering. The matter is well arranged and thoroughly readable, with plenty of illustrations and numerous worked examples and questions, with their answers. The present edition includes a new chapter on blowers and compressors, and another on the gas turbine

power plant. Ordinary British engineering units are used throughout, and the book could be unreservedly recommended to students, but for the way in which the theoretically important matter of thermodynamic reversibility is treated. The reader is told that the only requirement, for a process of expansion or compression to be reversible, is that there shall be no interchange of heat between the substance and its surroundings except under isothermal conditions; also that the only requirement for an isentropic process is that there shall be no interchange of heat with the surroundings at all. In both cases, the effect of any degradation of work into heat, by friction or turbulence in the substance, is completely ignored. Disregard of this point is responsible for the difficulty so many students find in understanding that the theoretical PV diagram, or any of the equations corresponding to its area, only represents the work done in a thermodynamically-reversible process, whatever the index of expansion may be. In spite of this criticism, the book may be regarded as one of the better treatises in its class.

Modern Electric Lamps.

By D. A. CLARKE, B.A. Blackie and Son, Limited, 16, William IV-street, London, W.C.2. [Price 20*s.* net.]

THIS book is one of a series in which a particular section of electrical engineering is dealt with in a comparatively small space at first-degree standard. It deals almost exclusively with light sources, and the temptations to delve into history, describe fittings and rush into theory have all been more or less successfully resisted. It is true that a long opening chapter deals with the nature of light and two equally long concluding chapters with the principles of illumination and with colour, but in between are some 150 pages which are devoted to detailed descriptions of the metal filament lamps and of discharge lamps of various kinds. It cannot be said that much of the matter is new or has not been published before, but the book brings a great deal of scattered information between two covers and that, perhaps, is its justification. Our only serious criticism is that so little space has been devoted to the new devices utilising high energy discharge in gases—such as the so-called gas arc and the flash tube. In fact, the chapter on this subject is little more than a summary of Dr. J. N. Aldington's work, to which the reader is referred for further information. A good account is given of the characteristics and methods of manufacture of the metal-filament lamp, and the properties of the various types of discharge lamps and their accessory equipment are also well described, although in this case constructional details are not so fully dealt with. The book, which is excellently illustrated, can be recommended for study as a supplement to more general text books. Except in the case indicated above and in the chapter on colour, there is no bibliography, and the index is regrettably meagre.

Pioneers of British Industry.

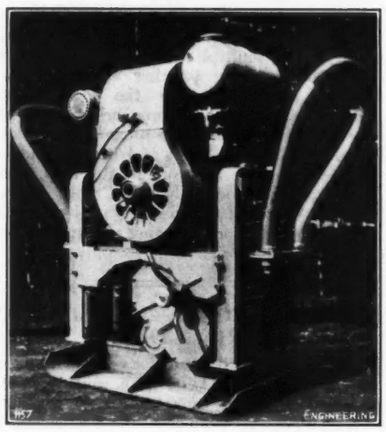
By F. GEORGE KAY, F.R.S.A. Rockliff Publishing Corporation, Limited, 1, Dorset-buildings, Salisbury-square, London, E.C.4. [Price 25*s.* net.]

WHILE it is a sound principle that those who desire definitive information should go to original sources for it, there is a distinct sphere in these days for the author who can summarise and interpret the advances of science for the benefit of the multitude who require only so much of that knowledge as will provide a reasonably dependable background to their own contacts with the life of to-day. That is the function of writers such as the late Henrik van Loon, and now of Mr. Kay, whose book—sub-titled on the dust jacket (and presumably, therefore, by his publishers rather than himself) as dealing with "The Men of Faith who built our Nation's Wealth"—covers a very wide field of applied science and, barring a few minor slips, does it well. Much of the text is a condensed paraphrase of the work of earlier authors, such as Smiles—that is inevitable; but the bibliography shows how widely Mr. Kay has ranged in his reading and that he has selected his sources with some discrimination. There is a good index, and the illustrations, in general, are well-chosen for their interest and originality.

SOIL-COMPACTING MACHINE.

A HIGH efficiency of soil compaction is achieved with the machine, shown in the accompanying illustration, which has been introduced by Compactors Engineering, Limited, 65, Effra-road, London, S.W.2. Though it weighs only 4½ cwt., it produces compacting blows up to 1 ton in intensity at a rate of up to 2,200 per minute. The compacting blows are transmitted to the soil through a baseplate 18 in. square. The machine is controlled by one man and is capable of propelling itself, while vibrating and compacting, at a speed of 40 ft. per minute, thus covering an area of 400 sq. yards per hour.

Known as the Junior Vibrosoil compactor, the machine is similar in principle to a larger compactor, made by the same firm, which was described in ENGINEERING, vol. 169, page 276 (1950). The vibration and compacting force are derived from three shafts which carry three out-of-balance weights, one on each shaft. In one plane these weights cancel each other, but in a plane at right angles they produce a compacting force downwards and a lifting force upwards. The shafts are driven by a 4·5-h.p. petrol engine through two V-belts, the engine being supported on a horizontal plate to



which the handles are attached, as shown in the illustration. This plate is suspended between groups of helical springs and rubber washers so as to isolate the engine and the handles from excessive vibration.

The frame of the machine, together with the baseplate and the vibrator unit—comprising the shafts out-of-balance weights and housing—are raised about ¼ in. from the ground once every cycle. The housing of the vibrator unit is visible in the illustration; it is in the lower part of the machine, behind the star handle. It can be swung about a horizontal axis so as to vary the angle, relative to the ground, of the direction in which the out-of-balance forces act. Thus, with the housing in such a position that the forces act vertically, a pure compacting action, without any tendency to propel the machine, is produced. With the housing swung towards one of the handles, however, the forces act at an angle to the soil surface; then the vertical component of the forces compacts the soil and the horizontal component propels the machine, the direction in which it is propelled (and the speed) depending on the direction in which (and the amount by which) it has been swung. The housing is locked in the required position by the star handle. The speed of vibration is varied by adjusting the engine control.

The compactor can be used on soil, gravel, crushed stones, ashes, hardcore, and dry concrete. It is suitable for compacting foundations—its small size being an advantage for this type of work—for backfilling trenches, for preparing pavements prior to laying slabs, and for reinstating roads and streets. The makers state that the compaction of the soil is effective to a considerable depth.

BOOKS RECEIVED.

National Research Development Corporation. Report and Statement of Accounts for the Year 1st July, 1951, to 30th June, 1952. H.M. Stationery Office, Kingsway, London, W.C.2. [Price 9*d.* net.]

The Structural Use of Timber in Buildings. British Standard Code of Practice CP 112 (1952), General Series. (Incorporating CP 112. 100—*Preservative Treatments for Timber Used in Buildings.*) The British Standards Institution, 24-28, Victoria-street, London, S.W.1. [Price 10*s.* 6*d.*, post free.]

Mining Machinery. By THOMAS BRYSON. Third edition. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 35*s.* net.]

Radio Upkeep and Repairs. By ALFRED T. WITTS. Seventh edition. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 12*s.* 6*d.* net.]

The Gantt Chart. A Working Tool of Management. By WALLACE CLARK. Third edition. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 12*s.* 6*d.* net.]

Handbook of Aeronautics. No. 1. *Structural Principles and Data.* Fourth edition. Published under the authority of the Royal Aeronautical Society. Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, Kingsway, London, W.C.2. [Price 45*s.* net.]

Royal Photographic Society of Great Britain. Library Catalogue. Part 2—Subject Catalogue. Offices of the Society, 16, Princes Gate, London, S.W.7.

Remote Control by Radio. An Amplitude-Modulation and an Impulse-Modulation System. By A. H. BRUINSMA. Philips' Gloeilampenfabrieken, Technical and Scientific Literature Department, Eindhoven, Holland. [Price 4.50 florins]; and Cleaver Hume Press, Limited, 42a, South Audley-street, London, W.1. [Price 8*s.* 6*d.*]

Getriebelehre. By DIPL.-ING. P. GRODZINSKI. I. *Geometrische Grundlagen.* Walter de Gruyter and Company, Genthiner Strasse 13, Berlin W.35. [Price 2·40 D.M.]

Rigid Frame Formulas. By PROFESSOR A. KLEINLOGEL. Translated from the German *Rahmenformeln*, eleventh edition. Based on a translation by F. S. MORGENROTH, revised and enlarged. Frederick Ungar Publishing Company, 105, East 24th-street, New York 10, U.S.A. [Price 10 dols.]; and Crosby Lockwood and Son, Limited, 39, Thurloe-street, London, S.W.7. [Price 75*s.* net.]

The Cathode Ray Oscillograph in Industry. By DR. W. WILSON. Fourth revised edition. Chapman and Hall, Limited, 37, Essex-street, London, W.C.2. [Price 36*s.* net.]

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